University of Alberta

The Detection of Unmodified Flake Tools in Archaeological Assemblages in the Eastern Slopes, Alberta.

by

Dennis Michael Sandgathe ©

A thesis submitted to the Faculty of Graduate Studies and Research in partial fulfillment of the requirements for the degree of Master of Arts

Department of Anthropology

Edmonton, Alberta
Fall 1998

National Library
of Canada

Acquisitions and
Bibliographic Services

395 Wellington Street
Ottawa ON K1A 0N4
Canada

Bibliothèque nationale
du Canada

Acquisitions et
services bibliographiques

395, rue Wellington
Ottawa ON K1A 0N4
Canada

Your file Votre référence

Our file Notre référence

The author has granted a non-exclusive licence allowing the National Library of Canada to reproduce, loan, distribute or sell copies of this thesis in microform, paper or electronic formats.

The author retains ownership of the copyright in this thesis. Neither the thesis nor substantial extracts from it may be printed or otherwise reproduced without the author's permission.

L'auteur a accordé une licence non exclusive permettant à la Bibliothèque nationale du Canada de reproduire, prêter, distribuer ou vendre des copies de cette thèse sous la forme de microfiche/film, de reproduction sur papier ou sur format électronique.

L'auteur conserve la propriété du droit d'auteur qui protège cette thèse. Ni la thèse ni des extraits substantiels de celle-ci ne doivent être imprimés ou autrement reproduits sans son autorisation.

0-612-34322-7

Canada

University of Alberta

Library Release Form

Name of Author: Dennis Michael Sandgathe

Title of Thesis: The Detection of Unmodified Flake Tools in Archaeological Assemblages in the Eastern Slopes, Alberta

Degree: Master of Arts

Year this Degree Granted: 1998

Permission is hereby granted to the University of Alberta Library to reproduce single copies of this thesis and to lend or sell such copies for private, scholarly, or scientific research purposes only.

The author reserves all other publication and other rights in association with the copyright in the thesis, and except as hereinbefore provided, neither the thesis nor any substantial portion thereof may be printed or otherwise reproduced in any material form whatever without the author's prior permission.

AUG. 27/98

Apt. 303 727 1 Ave. NW.
Calgary, Alberta, Canada
T2N-0A2

Date submitted

University of Alberta

Faculty of Graduate Studies and Research

The undersigned certify that they have read, and recommended to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled "The Detection of Unmodified Flake Tools in Archaeological Assemblages in the Eastern Slopes, Alberta" submitted by Dennis Michael Sandgathe in partial fulfillment of the requirements for the degree of Master of Arts

Pamela Willoughby

Pamela Willoughby

Raymond Le Blanc

Brian Kooyman

AUG. 25/98

Abstract

Lithic assemblages from many Eastern Slopes sites in Alberta are dominated by debitage of local raw materials that do not appear to be the result of formal tool production. This thesis investigates the possibility that these assemblages are mainly the result of the production of flakes for use as unmodified tools and that current approaches and attitudes, which favour formal tools such as projectile points, have overlooked the importance of these simpler tools in Middle and Early Prehistoric technologies.

Two factors in the Eastern Slopes would tend to support a prehistoric focus on expedient flake tools. The first is the relative durability and coarse lithologies of these local raw materials which may tend to resist use-wear better than other common materials such as cherts and obsidian. The second is the ubiquitous occurrence of these materials in this region which would allow people to ignore issues of economization of lithic resources.

Samples from three archaeological sites were examined under low power magnification for indications of use-wear based on comparisons to experimentally produced and utilized flakes. Extrapolations were made from the samples to the whole assemblages, providing an indication of the potential number of utilized flakes in these site assemblages.

A simple, practical approach for the detection of utilized flakes of silicified sedimentary materials is suggested.

Acknowledgements

I'm an indebted to a number of people and institutions for the support and assistance that allowed me to undertake and complete this thesis. The department of Anthropology at the University of Alberta provided me with financial assistance throughout my graduate studies in the form of teaching and research assistantships which provided invaluable experience as well as employment. The department also provided necessary equipment and resources and, Harvey Friebe in particular, provided technical advice. Thanks must go to my superviser, Pam Willoughby, for her advice, suggestions, support and time spent reading drafts. A similar debt of gratitude is owed Brian Kooyman and Ray Le Blanc, the other members of my defense committee. Both Ray and Brian were involved early in the thesis writing process and provided much needed discussion, recommendations and editing. I would like to thank Bob Dawe and Brian Ronaghan for providing me access to the assemblage from EkPu-8 and for providing me with figures of the site. Jack Brink shared his considerable knowledge and also provided occasional employment. Peter Francis provided me access to the 1626R and 243R assemblages and included in the excavations of these and other sites in the Eastern Slopes. Credit must be given to all those who took part in the excavations which provided the assemblages I used. Under the direction of Caroline Hudecek-Cuffe, excavations at 243R were carried out by fellow teaching assistants Alberto Musacchio in 1997 and 1998, and Darcy Mathews in 1996 and by 28 quite impressive students. Excavations at 1626R were carried out in 1994 and 96 by Parks Canada crews including Kurtis Lessick, Peter Francis, Jack Porter, and John Darwent. EkPu-8 was also excavated over several years involving an ever changing crew and while I am surely missing some people, I want to mention Brian Ronaghan, Jack Brink, Bob Dawe, Alwynne Beaudoin, Barb Kleespies, Daryl Bereziak, Shawna McGarvey, Morris and Elsie White and Tracey Sandgathe. Caroline Hudecek-Cuffe and Rick Lalonde produced and provided several of the maps included in the thesis. I would also like to thank Caroline for including me as a teaching assistant in the 1996, 97, and 98 excavations at 243R. A special thanks must go to Officer Stan Webb of Alberta Environmental Protection, District Officer-In-Charge of Calgary, who provided the deer carcass, his experience in dressing out game, and his advice in the experimental part of the thesis and who also got his arms in up to the elbows. My appreciation goes to both Stan and Olivia Webb for their support and generosity. A thanks to Sir Richard Burton and Sidi Bombay for their companionship and input at the computer terminal and finally I wish to give a special thanks to my wife, Tracey, for her support, advice, patience, and love.

Table of Contents

Chapter 1 Introduction . . . 1
1.1 Eastern Slopes Assemblages . . . 2
1.2 Questions . . . 5
1.3 Experimentation . . . 6
1.4 Analysis of Archaeological Assemblages . . . 7
1.5 Definitions . . . 8

Chapter 2 Related Previous Research . . . 12
2.1 Archaeology in the Alberta Rocky Mountains . . . 12
2.2 Use-Wear or Functional Analysis . . . 17
2.2.1 History . . . 17
2.2.2 Factors Influencing the Formation of Edge-Damage . . . 18
2.2.2.1 Incidental Edge-Damage . . . 20
2.2.3 Detecting and Quantifying Edge-Damage . . . 26
2.2.4 Experimentation . . . 27
2.2.5 Standardization . . . 27
2.3 Technological Organization . . . 28
2.3.1 Lithic Technologies . . . 28
2.3.2 Mobility and Settlement Patterns . . . 29
2.3.3 Access to Raw Materials . . . 30
2.3.4 Functional Design Criteria . . . 30
2.4 Unmodified Flake Tools . . . 32
2.4.1 Ethnographic Data . . . 32
2.4.2 Archaeological Research . . . 36

Chapter 3 Archaeological Sites . . . 41
3.1 243R (Snake Indian River, Jasper) . . . 41
3.1.1 Site Description . . . 41
3.1.2 Site Stratigraphy . . . 46
3.2 1626R (Ya-Ha-Tinda Ranch) . . . 50
3.2.1 Site Description . . . 50
3.2.2 Site Stratigraphy . . . 53
3.3 EkPu-8 (James Pass) . . . 57
3.3.1 Site Description . . . 57
3.3.2 Site Stratigraphy . . . 61

Chapter 4 Archaeological Samples 64
- 4.1 Theoretical Criteria for Selection of Unmodified Flake Tools . 64
  - 4.1.1 Size 64
  - 4.1.2 Edge Morphology 65
- 4.2 Selection of Archaeological Samples 67
  - 4.2.1 Age of Assemblages 68
  - 4.2.2 Raw Materials 68
  - 4.2.3 Size 71
  - 4.2.4 Edge Morphology 74
  - 4.2.5 EkPu-8 (James Pass) 75
  - 4.2.6 243R (Snake Indian River, Jasper) 76
  - 4.2.7 1626R (Ya-Ha-Tinda Ranch) 78
  - 4.2.8 Summary of Samples 80

Chapter 5 Lithic Raw Material 81
- 5.1 Raw Material Types 81
- 5.2 Raw Materials in the Alberta Rockies 85
- 5.3 Exotic Lithic Materials in the Alberta Rockies 88

Chapter 6 Experimentally Produced Control Sample 90
- 6.1 Use-Wear Experimentation 90
- 6.2 Thesis Experimentation 91
  - 6.2.1 Problems and Approach 91
  - 6.2.2 Experimental Tools 92
  - 6.2.3 Applications 94
    - 6.2.3.1 Part A 94
    - 6.2.3.2 Part B 96
  - 6.2.4 Recording Observations 102
- 6.3 Experimentation Results 112
  - 6.3.1 Part A 112
    - 6.3.1.1 Task Description 112
    - 6.3.1.2 Unaided Examination 113
    - 6.3.1.3 Microscopic Examination 114
    - 6.3.1.4 Summary of Part A Results 115
  - 6.3.2 Part B 117
    - 6.3.2.1 Task Description 117

6.3.2.2 Unaided Examination 117
6.3.2.3 Summary of Unaided Examination 120
6.3.2.4 Microscopic Examination 120
6.3.3 Summary of Experimentation Results 126

Chapter 7 Analysis of Archaeological Samples 132
7.1 Methodology 132
7.1.1 Microscopic Examination 132
7.2 Results of Examination 134
7.2.2 Early Prehistoric Sample 135
7.2.2.1 Taking Size into Account 136
7.2.2.2 Taking Degree of Edge-Damage into Account . . 138
7.2.3 Middle Prehistoric Sample 141
7.2.3.1 Taking Size into Account 143
7.2.3.2 Taking Degree of Edge-Damage into Account . . 144
7.2.4 Summary of Analysis of Samples 148

Chapter 8 Discussion of Analysis 156
8.1 Initial Analysis of the Site Assemblages 162
8.2 Microscopic Examination 163
8.3 General Task Visibility 164
8.4 Flake Size as Tool Selection Criteria 168
8.5 Factors Affecting Use-Wear Visibility 169

Chapter 9 Theoretical Discussion of Unmodified Flake Tool Technology . 172
9.1 Tools vs. Waste Flakes: the Peripheralization of Debitage . . 172
9.1.1 Expedient Tools 174
9.2 Technology and its Relation to Mobility and Settlement Patterns . 176
9.2.1 Mobility 177
9.3 Lithic Technology and Early Prehistoric Adaptations . . . 179
9.3.1 Resource Distribution 179
9.3.2 Technological Organization 181
9.3.3 Collectors vs. Foragers 183
Chapter 10 Conclusion 189
Plates 197

References Cited 200

Appendices 214

List of Tables

4.1 Summary of Middle Prehistoric Materials from EkPu-8 sub-assemblage 69

4.2 Summary of Early Prehistoric Materials from EkPu-8 sub-assemblage . 70

4.3 Summary of Middle Prehistoric Materials from Site 243R 70

4.4 Summary of Early Prehistoric Materials from Site 243R 70

4.5 Summary of Middle Prehistoric Materials from Site 1636R . . . 71

4.6 Summary of Middle Prehistoric Materials from Site 1626R . . . 71

4.7 Size Distribution of Early Prehistoric Debitage from all Three Sites . . 73

4.8 Size Distribution of Middle Prehistoric Debitage from all Three Sites . 74

4.9 Assemblage and Sample Sizes from Site EkPu-8 76

4.10 Assemblage and Sample Sizes from Site 243R 78

4.11 Assemblage and Sample Sizes from Site 1626R 79

4.12 Summary of populations and samples 80

6.1 Tasks and task materials included in Part B of the experimentation . . 98

6.2 Detail of degree of edge-damage on experimental flakes from Part B . 119

6.3 Degree of edge-damage relative to hardness of task materials . . . 120

6.4 Edge-damage observed with microscopic aid on flakes used in Part B 121

6.5 Summary by task mechanics of edge-damage observed in Part B . . 123

6.6 Summary of edge-damage compared to hardness of materials in Part B . 124

6.7 Frequency of edge-damage observed unaided, frequency of edge-damage observed at 20X, and the relationship of the former to the latter . . 125

7.1 Flakes from Early Prehistoric assemblages exhibiting edge damage at 20X 136

7.2 Sample size by cumulative size class and frequency of damaged flakes in each size class for all three Early Prehistoric assemblages 137

7.3 Summary of size distribution of Early Prehistoric samples and the frequencies of various levels of edge damage 139

7.4 Sample size by cumulative size class and frequency of flakes with substantial or extensive edge-damage for the Early Prehistoric assemblages . . 140

7.5 The frequency of Early Prehistoric sample flakes with any edge-damage and frequency of flakes with > substantial edge-damage 141

7.6 Flakes from the Middle Prehistoric assemblages exhibiting damage at 20X 142

7.7 Samples sizes by cumulative size class and frequency of damaged flakes in each size class sample for all three Middle Prehistoric assemblages . . . 143

7.8 Summary of samples from all three Middle Prehistoric assemblages and the frequencies of various observed levels of edge damage 145

7.9 Sample size by size class and the frequency of flakes with substantial damage in each size class sample for the Middle Prehistoric assemblages . . 146

7.10 The frequency of Middle Prehistoric sample flakes with any edge-damage and frequency of flakes with > substantial edge-damage 147

7.11 Summary of frequency of various levels of observed edge-damage in Early Prehistoric debitage from the Site EkPu-8 sub-assemblage 148

7.12 Summary of frequency of various levels of observed edge-damage in Early Prehistoric debitage from the Site 243R assemblage 149

7.13 Summary of frequency of various levels of observed edge-damage in Early Prehistoric debitage from the Site 1626R assemblage 150

7.14 Summary of frequency of various levels of observed edge-damage in Middle Prehistoric debitage from the Site EkPu-8 sub-assemblage 152

7.15 Summary of frequency of various levels of observed edge-damage in Middle Prehistoric debitage from the Site 243R assemblage 153

7.16 Summary of frequency of various levels of observed edge-damage in Middle Prehistoric debitage from the Site 1626R assemblage 154

8.1 Percentage of formal tools in each raw material assemblage from Early and Middle Prehistoric components of the three sites 156

8.2 Percentage of each raw material assemblage comprised of formal tools in the three sites, excluding items ≤ 5 mm in maximum dimension 158

8.3 Average maximum dimension of debitage from the three sites 159

8.4 Percentage of debitage in each raw material assemblage from the three sites that are >10 and > 5 mm in maximum dimension 160

8.5 Comparison of frequencies of levels of damage, observable with magnification, in the experimental and archaeological samples 167

List of Figures

3.1 Map of Alberta with Sites Indicated 44
3.2 Detailed Regional Map of Area around Site 243R 45
3.3 Diagram of Composite Stratigraphy of Site 243R 47
3.4 Detailed Regional Map of Area around Site 1626R 52
3.5 Diagram of Composite Stratigraphy of Site 1626R 55
3.6 Detailed Regional Map of Area around Site EkPu-8 59
3.7 Diagram of Composite Stratigraphy of Site EkPu-8 63
4.1 Graphic Example of Actual Flake Sizes 65
6.1 Illustration of flake orientation relative to terminology used . . 106
6.2 Diagram illustrating general flake margins 107
6.3 Diagram illustrating division of general flake margin into specific areas 108
6.4 Illustration providing examples of nature of wear 111
6.5 Illustration of Orientation of Flake Edge to Task Material . . . 116
6.6 Illustration of Detail of Orientation of Flake Edge to Task Material . 116
6.7 Illustration of Orientation of Flake Edge to Direction of Cut . . 129

List of Plates

Plate 1 Photograph of unused edge of silicified siltstone flake at 15X . . 197

Plate 2 Photograph of unused edge of silicified mudstone flake at 15X . 197

Plate 3 Photograph of example of spontaneous retouch magnified 7.5X . 198

Plate 4 Photo of experimental flake exhibiting attrition and microscarring . 198

Plate 5 Photograph of flake 5232A from 1626R with section of contiguous unifacial microscarring on ventral side and distal (trailing) end of use-edge . 199

Plate 6 Photograph of flake 5232A from 1626R with section of contiguous unifacial microscarring on dorsal side and proximal (trailing) end of use-edge 199

Chapter 1. Introduction

Among archaeologists, especially those dealing with prehistoric hunter-gatherers in North America, there appears to be a prevailing underlying attitude that well-formed formally shaped flaked stone tools, as opposed to unmodified or expedient flake tools (Binford 1977), were usually the main focus of lithic technological adaptations (Parry and Kelly 1987; Gero 1991). This preoccupation with formal tools is likely due in part to the heavy focus on culture-historic reconstruction throughout the history of archaeology for which formal tools, particularly projectile points, have proven to be effective due to style change over time. The vast majority of literature addressing lithic technology is devoted to the study and interpretation of formal or "curated" tools, their uses, their production, and their resulting debitage. This is most easily illustrated through a cursory look at the index volumes of the major archaeology periodicals under the subject headings of "lithics" or "stone tools". While archaeologists are certainly aware of the existence of utilized flakes, the effort spent on attempting to recognize them in assemblages falls far short of what the implications of their presence would demand (Young and Bamforth 1990; Bamforth 1985; Brose 1975). The level of significance attributed to bifacial technology within the current view of Early Prehistoric lifeways is likely unwarranted.

This thesis addresses issues involving the detection and identification of unmodified or "expedient" flake stone tools in Early and Middle Prehistoric debitage assemblages, specifically from the Alberta Rocky Mountains, but has potential implications for research elsewhere. A simple, practical approach for examining debitage is suggested which should provide a more accurate understanding of the importance placed on unmodified flake tools by prehistoric groups. Included is an analysis of how flake size and morphology may influence the prehistoric choice of unmodified flake tools. The discussion will include a look at the implications that a greater emphasis on expedient technology would have for a culture's technological organization (Shott 1986: 35). It must be stressed that the focus of this thesis is less on use-wear analysis and more on the potential implications that a greater focus on unmodified flakes might have for interpretations of Eastern Slopes Early Prehistoric lifeways.

1.1 Eastern Slopes Assemblages

The "Eastern Slopes", as the term is used here, refers mainly to the front ranges of the Rocky Mountains in Alberta. Early and Middle Prehistoric lithic assemblages from sites in the Eastern Slopes of Alberta tend to be dominated by locally acquired silicified fine-clast sedimentary materials such as silicified siltstone and silicified mudstone. These materials tend to be considered "lower quality" for the production of flaked stone tools because they tend to be more difficult to flake in a controlled manner than materials such as chert and obsidian.

These materials exhibit certain physical properties that are slightly different from the more commonly encountered lithic materials. In particular they tend to be harder, less brittle and, while normally quite homogeneous, do not always produce the typical flake morphology characteristic of the more commonly used materials. That is, flakes of these materials tend exhibit landmarks such as bulbs of percussion and compression rings less frequently and less clearly than do flakes of chert and obsidian. The physical properties of these local materials and the relative dearth of exotic materials suggest that adaptations by Early and Middle Prehistoric peoples in this region included an almost exclusive focus on the use of these local materials. The physical properties of these local materials, however, give rise to two factors that could have affected prehistoric adaptations in this region.

The first factor is that the relative hardness and lack of brittleness result in silicified clastic sedimentary materials being somewhat more difficult to flake in a controlled, predictable manner. While some formal tools such as projectile points were produced prehistorically from silicified siltstones and silicified mudstones, more effort and skill are required to produce formal bifacial tools from these materials than from cryptocrystalline materials such as chert or obsidian. This becomes immediately apparent to any modern knapper, regardless of the level of his or her individual skill, who has learned and practiced on obsidian or chert. The probability of failures in the manufacturing process is also greatly increased (Gryba 1997, personal communication). Many of the projectile points recovered from these sites are manufactured from cherts, chalcedonies or finer grained quartzites, all of which either occur locally in negligible quantities or had to be acquired from outside the region. Data collected so far for the Eastern Slopes indicate that people were certainly capable of manufacturing formal tools from the abundant local materials. However, the ratio of debitage to formal tools of these materials suggest that, given a choice, these people opted to produce their formal tools from other, less abundant or less readily available, materials that were more amenable to controlled flaking. This prompts the question: for what purpose were prehistoric people in this region reducing the majority of this local raw material. The most obvious answer is that these local materials were being reduced mainly to produce unmodified flake tools. These flake tools could then be applied to necessary daily tasks themselves or could be used to produce formal tool types from bone or wood.

Any relative increase in the level of hardness and decrease in brittleness (in comparison to obsidian or chert) would be an added advantage in a flake tool, since the edge of a flake tool is sharper, but is also typically weaker, than that of a bifacially worked one.

The second factor is that these specific physical properties of the local materials also tend to result in their being less prone to *acquiring* use-wear. The clastic nature of most of these materials also means that the surfaces of tools manufactured from them have greater comparative surface relief (than the rather glassy surfaced cherts and obsidians), which may result in their being less prone to *exhibiting* use-wear that would be visible without aid of magnification. Frison, in his experimental butchery of African elephant carcasses, found that the edges of chert tools dulled more quickly than those of quartzite. He surmised that this was due to the relative graininess of the quartzites which will wear in an uneven manner compared to the cherts in which the entire contact surface of the tool will be compromised by any wear (Frison 1989: 777). It is those points of greatest positive relief which are likely to acquire use-wear first (Kooyman personal communication, 1997), but because initial wear may be restricted to just these individual high points, items with limited wear may require magnification to detect the wear. On a relatively even surfaced material, such as chert or obsidian, patterns of wear (resulting from comparable task and duration as that which would create the wear described above) will tend to be in the form of contiguous damage and, therefore, they are potentially more readily visible to the unaided eye. This is of particular note as Semenov (1964: 14) suggested that striations are the most important type of damage in the detection and interpretation of actual use-wear. In the case of these raw materials of relatively coarse lithologies striations are less likely to occur in forms that would be readily visible.

Typical approaches to analysis of lithic assemblages recovered from Eastern Slopes sites involves, as is common elsewhere, simple "no magnification", visual examination of debitage for macroscopic modifications. It is these obvious modifications that are then used to distinguish flake tools from those flakes which, apparently, have not been utilized or modified and are simply "waste" flakes. This has (rightly) been questioned as a suitable approach in the analysis of assemblages from other regions where more commonly encountered raw materials such as chert or obsidian are the dominant stone tool media (Young and Bamforth 1990: 403).

1.2 Questions

A/ Given the specific nature of Eastern Slopes assemblages (the apparent limited acquisition of exotic materials) and the local lithic resource availability situation, could prehistoric adaptations to the Eastern Slopes have relied more heavily on expedient flake tools (the production of which is less constrained by raw material "quality") rather than the greater time/energy intensive approaches of either manufacturing formal tools from local materials or trading/traveling to acquire more flakable materials?

B/ Do the physical properties of raw materials such as silicified clastic sedimentary rocks make the formation, and thus the detection, of use-wear on utilized flakes more difficult? What general applications, and extent of use, are necessary to produce wear that is detectable using practical analytical methods?

C/ How does flake size influence the choice of items of debitage for use as unmodified tools?

D/ What would be a practical approach to debitage analysis that would allow better detection of utilized flakes that might otherwise go undetected through examination with the unaided eye?

If a greater proportion of flakes with no modification were being employed as tools and these are going undetected by analysts, then archaeologists are not getting an accurate understanding of prehistoric technological organization in the Eastern Slopes. Included here will be a discussion of the potential implications of adaptations that are focused more on flake tool technology and local materials on the prehistory of the Alberta Rockies, and possibly other regions. In particular, what are the potential implications of this form of technological organization on mobility and settlement patterns? Unmodified flake tools are typically considered to be "expedient". That is, they are likely manufactured at the time and location they are required, have a limited use-life (perhaps applied to only one task), and are then discarded immediately upon completion of the task. That these tools would be easily discarded seems logical given the limited effort involved in producing large numbers of them. It is not, however, necessarily the only pattern of use of flake tools. It is not impossible that some unmodified flake tools produced at a location for application to tasks carried out at that location were then retained by individuals upon departure from that location. In such a scenario the term "expedient" becomes problematic.

Experimentation was carried out in this research to attempt to provide some insight into the degree of visibility of utilized flakes in Eastern Slopes assemblages.

1.3 Experimentation

For this study an experiment was designed in which flakes were produced and then, without prior modification, were applied to a variety of tasks. These flakes then served as comparative specimens for identifying potential use-wear in selected archaeological samples. Some everyday-type tasks that would be expected by this researcher to have been carried out with stone tools throughout prehistory were performed in controlled conditions. These included cutting fresh meat, cutting fresh hide, cutting tanned hide, scraping fresh hide, cutting and scraping wood, cutting and scraping antler, and cutting dried grass and tubers.

The unmodified flakes used in the experiments were then examined under a low powered microscope and their appearance was compared to pristine flakes of the same material that had not been used. Any wear patterns observed were described and quantified.

1.4 Analysis of Archaeological Assemblages

Archaeological Samples

Samples of debitage were selected from three different sites located in the Eastern Slopes of the Alberta Rockies. The entire debitage assemblages of these sites had been analyzed previously. This analysis had included an unaided visual examination to detect use-wear. A further analysis of the samples was conducted, involving a second unaided visual examination as well as low powered microscopic examination, to determine if significantly more utilized flakes were present and could be recognized than had been detected in the initial analyses.

The Archaeological Sites

Two of the sites examined are in close proximity to one another in the front range of the Alberta Rocky Mountains west of the town of Sundre. Initial interpretations are that the first site, EkPu-8, was a lithic workshop location because it, and the majority of the floor of the mountain pass in which it is situated, have very high concentrations of debitage of locally acquired materials (Ronaghan 1993). The other, Site 1626R on the adjacent Ya-Ha-Tinda Ranch, is located on a high cutbank overlooking Scalp Creek. It appears to have been consistently re-used for short-term campsites. Occupations are thought to have been short-term due to the very limited areal extent of the components (some estimated to be as small as 50 square meters), the presence of butchered faunal remains in small quantities (specifically, elements typical of food processing rather than of kill locations), and the variety of stone tools and debitage present, although with a notable scarcity of projectile points (Darwent 1995). Both these sites have multiple components with ages that span most or all of the Holocene. The third, Site 243R, is a multiple component site in the north end of Jasper National

Park on the Snake Indian River. Radiocarbon dates and projectile point styles indicate that its components also span the Holocene. The nature of Site 243R is still under investigation although initial information suggests it may be a campsite reused for short periods by groups travelling through the Snake Indian River Valley between the Athabasca River Valley and the Western Rockies (Hudecek-Cuffe 1998).

1.5 Definitions

Problems consistently arise in archaeology with the definitions of terms and the implications these might have. Confusion can arise due to differences in individual, regional, and continental usages of the same terms. Lithic analysis is no exception. Several terms that are specific to lithic aspects of archaeological studies can potentially cause confusion and miscommunication. Several have been singled out here for clarification as to how the term is being used in this thesis.

Flake. The term flake can cause potential problems because it is used as a general term for any individual item of lithic debitage in some cases but can have more specific meaning in others. For example Sullivan and Rozen (1985) and others have divided debitage into types, of which, flakes are one and shatter another. In this thesis the more general definition is employed. When the term flake is used here it refers to any detached piece.

Utilized Flake. This is a flake that has simply been applied in some manner to a task or tasks. Whether or not the flake was specifically produced for this use is not known or implied. The flake edge may be modified as the result of the use, but the term carries an implication that the flake has not been intentionally modified prior to use. Exceptions to this may be flakes which have had one margin modified in order to blunt that margin to protect the user's hand.

Problems arise in the use of application of this term to flakes that were intended for use in an unmodified condition but exhibit no evidence of utilization. It seems erroneous to refer to a flake that was not utilized as a utilized flake, even if it had been produced for use as a tool. The term "utilized" is past tense making its application to intended, but unused, tools problematic. However, for purposes of simplification this will be the term most often employed here in reference to unmodified flake tools.

Retouched or Marginally Retouched Flake. This is a flake that has had minor retouching or flaking along an edge or edges that presumably altered it in a manner that made it more suitable for application to a task. Unfortunately it is not clear whether, in the general analysis of site assemblages, a distinction is always made between marginally retouched flakes and utilized flakes. This is not so much an issue of lax analytical practices as it is a problem of gradation. Utilized flakes that have been used to scrape harder materials can acquire use-wear that can look very much like marginal retouch and some flakes that might most accurately be called retouched might resemble more formal unifacial tools such as endscrapers. Flake-scar size has been used to arbitrarily distinguish retouch from use-wear. Three millimeters is suggested as a maximum size for use-wear edge scars (Hayden 1979; Kooyman 1985; Tringham et al. 1974: 181). Marginal retouch, however, most resembles attritional edge-damage associated with the scraping of hard materials. These two forms of edge-modification should typically be easily distinguished because retouch is usually comprised of mainly feather terminated scars each of which is easily distinguised from adjacent scars and the use-damage is usually in the form of overlapping and stacked microscars and microchipping which results in edge attrition. Marginal retouch would not typically be confused with most other forms of use-wear. The size of the flake scars would tend to prevent this.

Marginal retouch might be confused with rare examples of experimentally produced trampling damage (e.g Flenniken and Haggarty 1979: 211; McBrearty et al. 1998: 114). However, because of the apparent rarity of these trampled examples this would seem to be a non-issue.

Expedient Tool. This term refers to tools that are produced for a task at the time it arises, employed in the task and then subsequently discarded at the place of use. Some confusion can arise with this term when it is used interchangeably with utilized flake. Utilized flakes, while perhaps expedient in most cases, are not necessarily expedient as some ethnographic examples indicate (e.g., Binford 1979: 263; Gould 1980: 124).

Curated Tool. This term was coined by Binford (1977) and is defined in contrast with the term expedient tool. Curated tools are those that are manufactured in anticipation of their required need at some later time, they may have multiple purposes and after each use they are not discarded but are retained in the individual's possession for future use. They are also typically maintained, as in the case of stone tools which may be sharpened occasionally as they are dulled by use.

Formal Tool. The term formal tool is used here to refer to a lithic item that results from the obvious, often substantial, intentional modification of the shape of a flake or core into an item that is recognizable as a specific type of tool (as defined by archaeologists or in reference to ethnographic evidence) which usually carries an assumption of its intended application. Examples of common formal tool types are bifaces, projectile points, endscrapers, and sidescrapers. This is a definition that might be acceptable in North America but might cause some confusion for people more familiar with Old World terminology where formal tools can include items, such as denticulates, that have had limited modification in the form of marginal retouch.

Chapter. 2. Previous Research

This thesis includes three main areas of archaeological research. One, the Eastern Slopes of Alberta, is regional, the second, use-wear studies, is generally analytical and the third, technological organization, is theoretical in nature. Each area has an associated history of research and collection of literature. Because this thesis deals, in part, quite specifically with unmodified flake tools, a section on previous research in this area has also been included.

2.1 Archaeological Research in the Alberta Rocky Mountains

The Rocky Mountains, as they occur in Canada, are comprised of three major discrete north-south oriented ranges of mountains. The portion of the Canadian Rocky Mountains that is in Alberta includes mainly the Front Ranges with very little of the Main Ranges. West of the Main Ranges, which are primarily in British Columbia, are the Western Ranges which are entirely in British Columbia. Thus, when viewing the major Canadian mountain ranges as a whole, only a portion of the eastern periphery is in Alberta (Gadd 1995). Because of this the Alberta Rockies are also sometimes referred to as the Eastern Slopes. From an archaeological point of view, the Alberta Rockies seem to have been isolated from the rest of the Canadian Rockies because the material record here often appears to have as much or more in common with the adjacent Foothills and Plains than it does with the mountains further to the west (e.g., Ronaghan 1980; Duke 1986). This appearance may, however, stem from the fact that archaeologically research began earlier in the Northern Plains and, so far, more is known of the prehistory of this region than of the mountainous regions west of Alberta (Ronaghan 1986).

Within the Alberta Rockies themselves, systematic archaeological investigation is little more than 30 years old. The development of an understanding of the archaeology of this region is further hampered by the fact that different, but directly adjacent, areas of this region fall under the jurisdiction of different governmental agencies. A major portion of the Alberta Rocky Mountains is comprised of three national parks, Jasper National Park, Banff National Park and Waterton Lakes National Park. The archaeological resources in these regions are currently managed by Parks Canada Archaeological Services. The Ya-Ha-Tinda Ranch on the Upper Red Deer River adjacent to the northwest boundary of Banff National Park is not a national park but is managed by the federal government and so the archaeological resources here are also managed by Parks Canada (Francis, personal communication 1996). The rest of the Alberta Rockies are under provincial jurisdiction and since 1975 the archaeological resources here have been managed under the Alberta Historic Resources Act.

A large percentage of the archaeological research conducted in the Eastern Slopes over the last 20 years has also been carried out by archaeological consultants preceding development of one type or another or by archaeologists under contract with Parks Canada.

As would be expected, initial investigations in the Eastern Slopes involved systematic and semi-systematic surveys of subregions, such as major river valleys or major mountain passes. These surveys involved various levels of investigation, but typically took the form of simple surface surveys and/or subsurface shovel testing. The nature of the mountain terrain and environment, and a greater rate of landscape change, result in work here being difficult and complex. The potential for successful investigations in the Eastern Slopes is somewhat reduced when compared to the adjacent Plains (Ronaghan 1993).

National Parks

Very little archaeology was carried out in the National Parks in Alberta prior to 1970. The few minor projects that were carried out involved mainly mitigation of highway construction or other development (e.g., Reeves 1967, 1968, 1969). In

1970 two major regional survey and archaeological resource inventory projects were carried out in Banff, Jasper and Waterton Lakes National Parks by members of the Department of Archaeology at the University of Calgary in collaboration with the National and Historic Parks Branch (Elliot 1970; Reeves 1971 and 1970). The 1970 survey of Banff and Jasper National Parks included a surface survey of the Ya-Ha-Tinda Ranch as well. In 1970-71 further surveys were carried out in Banff National Park in the course of data collection for a Masters thesis by O. Christensen of the Department of Archaeology at the University of Calgary (Christensen 1971). The middle and late 1970s saw continued surveys carried out in various sub-regions of the National Park (e.g., Reeves 1972a).

Through the 1980s and 1990s the majority of data on the prehistoric and historic archaeology of the mountain parks has been collected by members of Parks Canada's archaeological staff (or by archaeologists under contract to Parks Canada) in the course of specific projects. Some of this work has involved continued regional surveys (e.g., Fedje 1987; Van Dyke 1987; Pickard 1984) but some of it has been salvage or conservation projects in the face of either natural erosion or ongoing construction and development. Occasionally these projects have led to the discovery of particularly significant prehistoric materials. For example, during archaeological investigations from 1983 to 1985, preceding widening of the Trans-Canada Highway in Banff National Park, the Vermillion Lakes Site was discovered. This site yielded large quantities of cultural material of various ages, the oldest of which was terminal Pleistocene based on radiocarbon dates between 10,000 and 11,000 years BP (Fedje et al. 1995). In the late 1990s salvage projects, in the face of natural erosion, led to the discovery of two of the sites, 1626R on the Ya-Ha-Tinda Ranch and 243R in Jasper National Park, from which data are included in this thesis (Francis 1996, 1997). Sites such as Vermillion Lakes, 1626R and 243R are rare examples of deeply stratified sites in the National Parks that contain cultural material spanning much of the period, from the recession of the glacial ice to the Late Prehistoric Period, during which the Eastern Slopes have been open for human occupation (Hudecek-Cuffe 1998; Francis 1997; Fedje et al. 1995).

Areas of Provincial Jurisdiction

Archaeological research in the Eastern Slopes outside of the National Parks has followed a similar pattern to that in the National Parks, with very little research being carried out prior to 1970. As development is necessarily limited within the National Parks, the one major difference is that far more of the archaeology undertaken outside the Parks has been conducted by consultants in the employ of private business and in conjunction with construction and development. While these sorts of investigations have contributed immensely to our knowledge of Alberta prehistory, with some exceptions they rarely involved serious detailed and systematic surveys and excavations (Ronaghan 1986).

While archaeological research in the adjacent Plains region of Alberta has a history which began in the 1930s and 1940s (e.g. Head-Smashed-In Buffalo Jump), it was not until the last 15 to 20 years that any serious methodical multi-year regional surveys and specific site excavations have been undertaken in the Alberta Rockies. This is, in part, due to the introduction of the Alberta Historic Resources Act in 1973. It produced a shift from academic research originating out of the universities to mitigation work being carried out by archaeological consultants (Ronaghan 1986; Reeves 1975). The much earlier start of work in the Plains is apparently due to the presence there of highly visible archaeological sites such as Head-Smashed In Buffalo Jump, the like of which are not present in the Alberta Rockies.

The Crowsnest Pass is the only major pass through the Alberta Rockies that does not go through one of the National Parks and has, therefore, received more attention beginning in the early 1970s. In 1972, several survey and salvage projects were carried out in the Crowsnest Pass (Reeves and Driver 1978; Reeves 1974). The Department of Archaeology at the University of Calgary held a field school here for several years in the early to mid 1970s (Driver 1976) and two theses were produced (Driver 1978; Ronaghan 1980). Several important early sites were also excavated in the late 1970s and early 1980s (Kennedy 1982; Ronaghan et al. 1982).

The areas in and around the Bow River Corridor east of the Banff National Park boundaries have received considerable attention as well. Work in the Kananaskis region began in the early 1970s (Reeves 1972b) and in the Bow Corridor area in the early to mid 1970s (e.g., Reeves 1973). Highway expansion through Sibbald Flats in the Bow Corridor in 1979 led to the discovery of the Sibbald Creek Site (EgPr-2) that produced, among other things, Early Holocene dates and projectile points that have been tentatively associated with the Clovis Culture (Gryba 1983). In 1988 and 1989, the Bow Corridor Project was created by the Archaeological Survey of Alberta and involved a more intensive and detailed survey of this region (Newton 1991). The late 1980s and early 1990s also saw similar surveys carried out in other major river valleys such as the North Saskatchewan (Ronaghan and Beaudoin 1988). Much of this work, however, may be more properly associated with the Foothills and western edge of the Plains than with the Eastern Slopes.

In the mid to late 1970s surveys (and limited excavation) were carried out in the Grande Cache region in the northern most portion of the Alberta Rockies. The surveys focused on the major lakes and river systems (Brink and Dawe 1986).

In 1991 the Archaeological Survey of Alberta began a survey and archaeological resource inventory of the James Pass area of the Upper Red Deer River region which resulted in the discovery of several sites including site EkPu-8. This project continued over several years and turned into a detailed multi-year excavation of EkPu-8 (Ronaghan 1993), data from which are included in this thesis.

These surveys were partly in conjunction with the Archaeological Survey of Alberta's "First Albertan's Project" which was instigated primarily to attempt to locate sites in Alberta that would potentially represent the earliest prehistoric inhabitants of the province (Magne and Ives 1991). This project was carried out with much emphasis being put on the long held "Ice-free Corridor" model (proposes that western Alberta was unglaciated late in the Pleistocene) which suggests that the earliest available regions for occupation in Alberta, following the retreat of the Wisconsin ice sheets, would be along the Foothills and Eastern Slopes of the Alberta Rockies (Magne and Ives 1991; Pielou 1991; Rutter 1984).

2.2 Use-wear or Functional Analysis

2.2.1 History of Use-Wear Research

The investigation of edge damage on stone tools has become an important aspect of current archaeological investigations. These investigations were instigated in part by frustrations with archaeology's long held assumptions about the functions of prehistoric stone objects. In interpreting the function of stone tools, morphological analysis is not necessarily reliable and is potentially misleading because current analogies may not exist and prehistoric tools for which apparently suitable extant analogies do exist may have had multiple uses. Understanding the cause of specific types of edge damage and recognizing that damage on artifacts would allow direct insight into the function of those artifacts (Vaughn 1985; Keeley 1980; Hayden and Kamminga 1979; Tringham et al. 1974).

Research into the nature of edge damage or use-wear formation is on-going and there is still a long way to go before archaeologists have a confident understanding of all the factors involved and their relative importance in specific situations. However, use-wear analysis has been, and is being applied in the investigation and interpretation of aspects of the archaeological record in some regions. For example, Nance (1971) examined the edge-damage on small serrated artifacts from central California that had long been interpreted to be projectile points. Based on the nature of the edge-damage he concluded that they had been used for other purposes (for example, see Vaughan 1985; Keeley 1977; Hayden and Kamminga 1979)

Use-wear investigation and experimentation began in the late nineteenth century (Hayden and Kamminga 1979: 3-4), but the initiation of current research into use-wear is typically credited to S. A. Semenov and colleagues at the Leningrad Academy of Sciences. The translation of some of Semenov's research (Semenov 1964) into English in 1964 prompted archaeologists elsewhere to begin similar research (e.g., Vaughan 1985; Hayden and Kamminga 1979; Keeley 1974; Tringham et al. 1974).

Use-wear analysis can be divided into two general areas of research. The first of these involves investigating the factors that influence the formation of edge damage. The second area involves trying to determine the most appropriate methods for detecting and describing edge damage on prehistoric implements.

2.2.2 Factors Influencing the Formation of Edge-Damage

Early on in use-wear research four major factors in the formation of edge damage were identified. These are: the type of material being worked, the nature of the use of the tool on that material, the morphology of the tool edge, and the raw material from which the tool is made (Keller 1966). Each of these major factors can be reduced to or divided up into several related factors.

Researchers have tended to subdivide materials being worked by relative hardness. The basic categories are typically hard, medium and soft. The issue of type of material being worked can be complicated. For example, it must be recognized that "wood" as a material category can be divided up into hard or soft, and green (fresh) or dry (Vaughan 1985). Dirt may be an important factor in the formation of edge damage in the scraping of hides or cutting of meat (Brink 1978). A single tool or tool edge may have been used on more than one type of material or during a single use came into contact with more than one type of material as in the case of cutting hide on the ground or on a board.

The nature of the use of a tool can have many different aspects. Ahler (1979: 302) identified four specific variables in the nature of tool application to material.

> *1/ the static orientation of the tool with respect to the material being worked.*
> *2/ the relative motion of the tool with respect to the work(ed) material.*
> *3/ the mode of force transferred from the user to the work(ed) material through the tool.*
> *4/ the presence or absence of hafting and the mode of prehension of the tool during use.*
>
> (from Ahler 1979: 302)

The morphology of the tool edge includes the edge angle (the angle between the dorsal and ventral faces 1 mm back from the edge - Hayden and Kamminga 1979), the spine-plane angle (the angle between the dorsal and ventral surfaces over the majority of the width of the tool cross-section), and the plan view of the use-edge (is the edge concave, convex, or straight).

The raw material from which the tool is made has been one of the least often addressed factors in the formation of edge damage. However, it is an important factor because the range of raw materials employed by prehistoric groups encompass a wide range of physical qualities. The degree of hardness and brittleness of the tool material will influence the nature of damage to its edge, as will the degree of surface relief of the raw material. A material with relatively low surface relief, such as obsidian, will acquire wear differently than a coarser material such as basalt or silicified siltstone. Understanding the mechanical/fracture properties of lithic materials has been a part of lithic analysis for some time (e.g., Cotterell and Kamminga 1979, 1987; Lawn and Marshall 1979). Investigations into the differences, in this respect, between different types of lithic raw materials has not been given much attention (Greiser and Sheets 1979; Ahler 1979; Goodman 1944).

2.2.2.1 Incidental Edge Damage (Trampling and Post-Depositional Processes)

A second problem faced by all use-wear analysts is distinguishing between intentional retouch, genuine edge wear resulting from application of the tool to a task(s), and incidental edge damage from other sources. The trampling of lithic artifacts that were laying on the ground surface has been recognized as one potentially major source of incidental edge damage (Gifford-Gonzalez et al. 1985; McBrearty et. al. 1998; Nielsen 1991). Other potential sources of wear include: the excavation process itself, contact between artifacts that have been placed together after recovery, the adherence of the worked materials to the tool edge (Brose 1975), and possibly post-depositional movement of artifacts in the sediments (Cahen and Moeyersons 1977). Potential sources of incidental edge-damage are recognized here to be, potentially, a very important consideration of this thesis.

Trampling

Several different experiments have been carried out over the last few decades that investigate trampling of assemblages by people as a source of edge-damage that could be mistaken for intentional retouch or use-damage (e.g., Flenniken and Haggerty 1979; Gifford-Gonzalez et al. 1985; McBrearty et al. 1998; Nielsen 1991; Pryor 1988; Shea and Klenck 1993; Tringham et al. 1974). Some of these studies indicated that differentiating between edge-damage caused by trampling and actual retouch or use-damage was not necessarily easy but should not be a major obstacle to use-wear analysis (Nielsen 1991: 500; Pryor 1988; Gifford-Gonzalez et al. 1985: 815; Tringham et al. 1974: 192). Most of these researchers indicated that occasional flakes, that underwent the trampling experiments, acquired edge-damage in form and quantity that would make them difficult to distinguish from intentionally retouched flakes.

produce unpatterned edge-damage in the form of irregularly spaced flake scars of irregular shapes and sizes. This tended to make this type of edge-damage quite distinct from intentional retouch or use-generated damage which, in the experiments conducted for this thesis, consistently occurred as sections of contiguous flake scars of regular shape and size. Three studies disagreed with the results and interpretations of those mentioned above (Flenniken and Haggerty 1979; McBrearty et al. 1998; Shea and Klenck 1993). Two suggested that the type of edge-damage that they produced on chert and obsidian flakes, through trampling, allowed the assignation of many of these flakes to specific tool classes such as Bordes' categories of formal Middle Paleolithic tools (Flenniken and Haggarty 1979: 211; McBrearty et al. 1998: 114). These researchers strongly suggest that trampling, as an agent of edge-modification, is very likely a major factor in the formation of edge-damage on prehistoric flakes and that this type of damage is easily and regularly mistaken for intentional retouch and use-wear. Three major criticisms, of these two studies in particular and which may apply to several of the other studies, are included here.

The first criticism is in the lack of control for the level or degree of trampling to which the experimental assemblages were subjected. In all studies mentioned above a single arbitrary duration of trampling or a single arbitrary number of passages over the assemblage was decided on and applied in various forms of the experiment. In the McBrearty et al. experiments (1998), each assemblage was trampled continuously for an hour by two people. As is typical in the other experiments, no explanation for why this specific duration was decided upon and no argument was put forward as to why the results of the experiments should then be comparable to archaeological assemblages. As it is impossible to know how much or how long any one archaeological assemblage might have undergone trampling by people, it is important that any attempts to replicate this process experimentally include a range of durations and/or intensities of the process. This would have allowed a more reliable range of results to which the archaeological data could be more objectively compared. A trampling experiment in which an assemblage was trampled by a dozen people for two days straight is probably not an accurate replication of potential prehistoric situations, but undoubtedly most or all of the flakes underfoot would have received extensive edge-modification. Theoretically the resulting data in this experiment would have as much scientific validity as any other arbitrarily designed experiment. In fact, in McBrearty et al. (1998: 113) it is stated that "The duration of the trampling.....probably resulted in more damage than normal prehistoric activities would produce in this amount of time."

Attempting to reconstruct prehistoric behaviour, situations, and processes is a valid and unavoidable aspect of experimental archaeology, but is best implemented in the form of a range of possible scenarios in order to dilute the potential contamination of the results by the inherent biases involved.

A second criticism involves the footwear worn by the individuals doing the actual trampling in the various experiments. In almost every study (with two exceptions noted below) it is explicitly mentioned that the experimenters wore either soft-soled or rubber-soled shoes. While not specifically explained, it seems logical that this is an attempt to replicate the prehistoric conditions in which people (assuming they were wearing some sort of footwear at all) would have worn footwear with soft soles. On the surface this is a logical approach to take. However, I am not convinced that a person would casually walk across an assemblage of debitage in footwear with a sole consisting of a single layer of leather (obviously depending on the leather thickness), especially if the assemblage was of obsidian (the most common raw material included in the trampling experiments). While the flakes may not actually cut through the leather to the individual's foot (although this is undoubtedly a possibility) the flakes will, in all likelihood, damage the footwear. This would be particularly the case if the individual walked back and forth over the assemblage for an hour or two or made a thousand passes as was the case in another set of experiments (Flenniken and Haggarty 1979).

It is also not necessarily the case that modern footwear, no matter how soft-soled, would accurately replicate the type and quantity of damage produced by a foot clad in leather. Unlike the soft-soled modern shoe, a single layer of leather (even thick leather) tends to conform to the shape of the foot which results in the distribution of weight being concentrated on certain portions of the sole, specifically the heel, ball and to a lesser degree the toes. In most modern footwear the weight tends to be more evenly distributed over the entire sole. The thickness of modern soles also prevents the wearer from feeling ground surface relief with the same level of sensitivity of single layer leather footwear. Feeling the ground surface relief (i.e., any objects upon which the individual might be treading) allows the individual to instantly modify the degree of weight placed in any one portion of the sole. This could have a significant impact on the level of damage caused to items underfoot. To Flenniken and Haggarty's (1979) and Shea and Klenck's (1993) credit, some of the experimenters in these studies did wear moccasins. However, some also wore soft-soled modern footwear and no attempt was made to separate or distinguish the respective damage caused by each type of footwear.

The final criticism included here is specifically of the McBrearty et al. (1998) results and interpretations. They suggest that a significant number of trampled flakes from their experiments would easily fit within accepted Old World typologies. Several drawings and plates of some of their, presumably better, examples were included in their published paper. While admittedly, drawings and plates are no substitute for examining the actual items, many of their included items exhibited damage that was comparable to intentional retouch, but unlike typical use-wear based on the generally large flake scars on the trampled items. While the extent of the damage in their experiments was, overall, greater than in most of the previous experiments, it still tended to be irregular in both placement of flake scars and size of flake scars.

As this thesis deals specifically with issues of use-damage and not retouch, trampling as a source of pseudo-retouch was not considered a factor here. Trampling as a source of pseudo-use-wear was considered a potential factor. However, all the available information on experimental trampling studies, even those that most strongly suggest trampling as a factor, indicated that it produced types and quantities of edge-damage that were not typical of actual use-wear. Following the experiments carried out for this thesis this became even more apparent. The majority of actual use-damage occurs in the form of sections of contiguous microscarring or microchipping (typically < 1 to 1.5 mm in depth) in which the size range of all the scars in a specific section is very narrow. Even in those instances in which contiguous damage occurred on trampled flakes the damage consisted of relatively large flake scars with no consistency of size (e.g., McBrearty et al.1988: figures 4 to 10). In cases where a flake was used to scrape a hard material for extended periods some larger flake scars occur. This scarring occurs in the form of attrition, however, in which flakes are removed from previous flake scars continuously. This form of edge-damage is quite distinct from damage that occurred from just one or possibly two discrete applications of pressure to that edge which would be typical of excessive trampling. The chance that a flake will be continuously trampled in just such a manner that a specific edge receives repeated applications of just the right amount and direction of pressure to remove again and again layers of contiguous damage seems remote to say the least.

Post-Burial Artifact Modifications

It has been suggested that in certain circumstances sub-surface movement of soil deposits may result in the formation of damage to the edges of flakes (Keeley 1980; Warren 1923).

Soil movement was an issue that was addressed in the analysis of the lithic assemblage recovered from Site 243R in Jasper National Park (lithic analysis appendix to Hudecek-Cuffe 1998 - report in progress). It was reasoned that if soil movement was a potential factor in the formation of edge damage then, all else being equal, flakes that were more deeply buried, and thus buried for a greater length of time, will tend to incur higher quantities/more extensive damage. This was not the case in the assemblage from this particular site. In the initial lithic analysis the percentage of flakes with identifiable edge damage was not higher in the lower stratigraphic levels. This would seem a strong argument against this type of process being a factor in the formation of edge-damage at this site, at least.

As the archaeological samples, from the three sites included in this thesis, included both Early and Middle Prehistoric components, the question of post-depositional edge-modification can be address through a comparison of these components.

Spontaneous Retouch During Production

A final source of potential edge-damage, spontaneous retouch, has been recognized by a number of different researchers (e.g., Brink 1978; Keeley 1974; Sheets 1973). During the production of the assemblage of flakes from which the experimental sample for this thesis was selected, one flake was identified as having spontaneous edge retouch that was a result of the flake rotating back against the core at the time of detachment (see Plate 3). This retouch was noticed at the time the flake was produced. It consisted of a section of contiguous flake scars all of a consistent and appropriate size for intentional retouch and would easily be mis-identified as such. It did not, however, resemble any of the use-wear produced in the experimental assemblage. The scars were larger (≥ 2 mm in depth) than was typical of most of the experimental use-wear and the pattern of the scarring was actually more regular than any of the use-wear.

2.2.3 Detecting and Quantifying Edge-Damage

Keeley, an early researcher in use-wear studies, put forward a harsh criticism of what he considered to be relaxed approaches in the microscopic detection and quantification of use-wear. He criticized the failure of most researchers to follow Semenov's (1964) strict methodology (Keeley 1974). This methodology included the use of high magnification microscopy (up to 180X or greater), the use of photographs, and the use of coating materials (colourizers or metalization) on the tool surface to counteract problems of translucency of siliceous materials. This type of approach, however, represents significant investitures of money and time.

In the 1970s and 1980s a debate arose between those researchers who employed high powered microscopy (e.g., Keeley 1974) and those who were proponents of the quicker and cheaper lower powered approach (e.g., Odell 1980: Odell and Odell-Vereecken 1980; Tringham et al. 1974; Keller 1966). This debate did not revolve simply around the relative speed and expense of the two approaches. It also involved the reliance on different levels of edge damage for interpretation of tool use (Yerkes 1987). While high powered approaches tend to rely heavily on the occurrence of polish for interpretations, the low powered approach looks more at edge scarring (Keeley and Newcomer 1977; Odell 1980; Odell and Odell-Vereecken 1980). Several blind tests have been carried out to attempt to test the accuracy of both approaches (Bamforth et al. 1990; Keeley and Newcomer 1977; Newcomer et al. 1986; Odell and Odell-Vereecken 1980).

2.2.4 Experimentation

It was apparent to researchers long before Semenov (1964) that it was necessary to carry out experimentation with modern versions of prehistoric stone tools in order to determine the nature of edge damage under specific conditions and to provide control samples to which observations from archaeological artifacts could be compared (see Hayden and Kamminga 1979 for a more in-depth coverage of the early history of use-wear experimentation). The wide range of approaches to use-wear experimentation over the last century has, not surprisingly, resulted in the formation of two schools of thought (this is discussed in more detail in the chapter dealing with the experimentation carried out for this thesis). The debate generally revolves around whether experiments should be set up to attempt to accurately reconstruct envisioned prehistoric tasks or whether the experiments should be focused more on attempting to isolate all pertinent factors in the formation of edge damage and determine their relative influence and importance under various conditions.

2.2.5 Standardization

One problem that has been recognized by all researchers is the need for more standardized methods of description and quantification of the varieties of edge damage that occur (e.g., Grace et al. 1985; Keller 1966; Schiffer 1979). The lack of standardization has severely limited the potential applicability of individual researcher's findings to other researchers' questions and to a wider range of archaeological assemblages. While the problem of standardization continues, its resolution may necessarily require a level of understanding of use-wear that is yet to be attained by archaeologists.

2.3 Technological Organization

2.3.1 Lithic Technologies

The study of stone tool technology in North America has resulted in a framework of understanding that recognizes two general approaches to the use of (suitable) stone as tools. The first approach, typically termed "Bifacial Technology", involves the production of specific tool types. The raw material, whether in the form of a core or a blank flake struck from a core, is reduced through the alternate removal of flakes from both faces of the item being worked. In this process all the debitage produced is essentially waste material and the intended product may typically be a single bifacial tool. These are often referred to as "formal" or "curated" tools (Binford 1977). A formal tool is assumed to have been produced for application to a specific task or range of tasks and is based on preconceived ideas of what that tool should look like. It is based on a mental template, which may be extremely specific or very general, and, after production, the tool is retained in a person's possession, or "curated", for repeated applications. Because these tools are thought to be retained by an individual over the duration of the tool's use-life, they were likely very often carried from location to location, perhaps used at some or all of these different locations, perhaps rejuvenated occasionally, and ultimately lost or discarded in a location potentially other than that where it was manufactured. This means that the presence of a formal or curated tool at a site does not necessarily mean is was manufactured or even used at that location.

The second technological approach, core reduction or core technology, involves the reduction of a cobble or nodule of suitable raw material into an assemblage of flakes. It is this debitage, or at least a portion of this debitage, that is the intended product and the assumption is that these pieces will be used as tools with little or no modification. Most of these flakes will have naturally sharp edges that require little or no modification in order to be suitable for application to a wide variety of tasks. Core technology is, rightly or wrongly, often assumed to represent a throw-away or "expedient" tool technology. The assumed or implied scenario is that flakes are produced as they are immediately required and are subsequently discarded after that specific task is completed. They are not typically thought to be retained in a person's possession for any extended length of time. If this assumption is correct then it would be expected that the presence of utilized flakes at a site means that the task(s) for which the flakes were used was undertaken at this location. This underlying assumption should be seriously questioned by archaeologists. Specific situations may make the practice of retaining unmodified flakes, produced at one location for potential application elsewhere, a practical behaviour.

The inherent advantages and disadvantages, or perhaps better put, the specific adaptive qualities of these two general approaches have led to discussions of the relationship of stone tool technology to other aspects of human adaptation that influence the nature of technological organization. Some of the different factors that potentially influence this relationship have been identified and discussed in the literature (e.g., Andrevsky 1994; Bamforth 1985 and 1986; Binford 1977 and 1979; Henry 1989; Kelly 1983; Kelly and Todd 1988; Meltzer 1985; Parry and Kelly 1987; Ricklis and Cox 1993; Shott 1986, 1989a, and 1989b; Wiant and Hassan 1985). Some of the identified factors include: level of mobility, settlement patterns, access to raw materials, and the nature of the different tasks for which tools are required or functional design criteria. As in most systems, none of the variables involved can be viewed or discussed in isolation from the others.

2.3.2 Mobility and Settlement Patterns

Some researchers (e.g., Parry and Kelly 1987) have argued that the simple bulkiness and excessive weight of core reduction/flake production make this technology much more suitable for less mobile groups for whom carrying objects from location to location was less of a concern. Kelly and Todd (1988) have similarly argued that the versatility of application of biface tools, combined with their minimal weight constraints, make them suitable choices for highly mobile groups. A biface, besides being a serviceable tool itself in a wide variety of tasks, can also serve as a source of unmodified flakes for other tasks.

2.3.3 Access to Raw Materials

For reasons that are evident, raw material is not easily extricable from the variables of mobility and settlement patterns. The initial factor influencing access to materials is the distribution of suitable raw materials over the landscape. Where are sources of raw materials located and how much is available? Are lithic sources ubiquitous enough in a region so that mobile groups can confidently anticipate encountering some wherever they go or must concerns about acquisition be specifically include in their plans? If a group is more sedentary, do they locate their settlement near to a lithic raw material source or can they practically opt to send out occasional task groups specifically to retrieve quantities?

Beyond this, the spatial relationship between these raw material sources and other resources used by people becomes an important factor. Are special trips necessary to exploit the lithic raw material resources or can this exploitation be made in conjunction with, or "imbedded" in, other behaviours (Binford 1980)?

In some regions suitable raw materials may be unavailable, in which case a group may be forced to travel to other regions or carry on trade relations with adjacent groups who do have access to raw material sources.

2.3.4 Functional Design Criteria

Some tasks may require tools with specific attributes and some may require little in the way of specific design at all. Many tasks involving cutting may require little more than a hard, sharp edge. The edge of a unmodified flake is typically sharper than the for most cutting tasks and perhaps necessary for cutting tasks that require greater precision. Unmodified flake edges tend to be, however, structurally weaker than the edge of a biface tool. Some cutting or sawing tasks may require the application of pressure that is too great for an unmodified flake edge to bare. In these cases a bifacial tool may be necessary. Some tool functions require quite specific designs. Projectile points may be a good example of this. Their function is highly specialized. Projectile points require a high level of structural strength that will better withstand high velocity impacts. This is accomplished with a lenticular shape. They would tend to need to be symmetrical in order to fly in a straight line, and they must include physical attributes that will allow their secure hafting to the projectile shaft, i.e., fluting, a stem, or notches.

2.4 Previous Research Dealing with Unmodified Flake Tools

2.4.1 Ethnographic Data

While ethnographic information regarding stone tool use is not particularly rare, most of the information addresses mainly the production and use of formal, stylized tools. There are few accounts of the use of stone flakes and even fewer that deal with the specific manufacture of these. However, there are some exceptions of note.

Several researchers working in New Guinea have described the manufacture and use of unmodified flake tools. These include White and Thomas (1972), Strathern (1969), and White (1968 and 1969). White (1968) provides a reasonably detailed description of the production of unmodified flake tools by a group of men in the New Guinea Highlands.

> The core could be . . . struck with any convenient hammerstone until either the core broke or flakes were detached.
> . . . Flakes or cores were selected for use as tools if they were of a convenient shape to hold and have a sharp edge suitable for the work at hand. Particular shapes are [not] produced by preparation of the core . . .
> All tools are hand-held and should a sharp edge interfere with a comfortable grip, the edge is blunted by striking it vertically several times on another stone . . . This was the only secondary retouch to artifacts that was observed. (White 1968: 512-13)

From field work carried out in Brazil among the Xeta Indians, Miller (1979) also provided a first hand account of the production of unmodified flake tools intended for application to woodworking:

> After striking off each flake, Kwe examined the edges and experimented with [them] in his hand to see if it could be easily held, or if there were sharp edges that might cut him . . .
> Nheengo [collected] the flakes he considered useful, pushing aside the rejects and waste. He examined and chose his tools carefully....
> The vast majority of the flakes . . . were not retouched before being used and their sizes and shapes were extremely varied.
> . . . the informants tried out the stones empirically, one after another, to determine the tools best suited for any particular task. Once a stock of stone tools had been accumulated, the informants were ready to start the woodworking. (Miller 1979: 402-3)

Gould (1980) provides some more general information about the use of unmodified flake tools among the Western Desert Aborigines of Australia:

> Stone from . . . nonlocalized sources (sources not close to base camps) were generally used as instant tools, for some immediate task at or near the place where the stone was collected.
> Aborigines, both male and female, sometimes picked up sharp stones to use when roasting and butchering a kangaroo or other game. In nearly every observed case, the Aborigines disposed of stone tools they collected and/or manufactured at nonlocalized sources of stone at the place where the tool was used. Regardless of whether or not they had been retouched by the Aborigines, these instant tools were rarely carried away.....for further retouch and/or use.
> . . . if a spearshaft required trimming, a simple, unretouched flake was sometimes used as a spokeshave. These tools were not saved or reused. They were produced as needed, at habitation campsites or in task-specific localities . . . (Gould 1980: 124, 127)

Gould provides evidence that sometimes unmodified flake tools did not need to be specifically produced for a task at hand and that flakes not specifically produced for use as unmodified flake tools could also be used for application in tasks where specifically produced unmodified flakes might most commonly be used.

> . . . Flake knives . . . were used mainly for cutting meat and sinew . . .
> In most cases, flake knives were made of stone from nonlocalized sources. Sometimes naturally sharp-edged flakes found lying on the ground were picked up and used as flake knives, thus constituting an important variety of instant tool. There were also cases observed, however, where sharp waste flakes left over from adze production . . . were picked up by someone...and used for a cutting task. (Gould 1980:131)

Binford (1979) provides some second hand information from among the Nunamiut Eskimos of Alaska about the use of unmodified flake tools:

> Informants always spoke of carrying "cores" into the field. . .
> . . . flakes (were removed) radially from the (core) for use in butchering animals . . . (Binford 1979: 262)

Although the Western Desert Aborigines of Australia may have rarely retained unmodified flake tools after a specific use episode, Gould (1980) implies that this may have occurred on occasion (see quoted excerpt above). Nunamiut men, on the other hand, appear to regularly carry unmodified flake tools in their personal tool kits on outings:

> . . . flake knives, simple flakes from relatively large cores used in butchering, were carried in a small pouch worn in much the same manner as an ammo pouch . . . (Binford 1979: 263)

Binford provides an example situation in which some hunters unexpectedly found themselves in a position to acquire several caribou without much work. They went ahead and killed the caribou, but since the situation was not anticipated they had not carried with them typical butchering gear and had to produce "situational gear":

> We go around the lake looking for shiny stones . . . uncle fix little hammer of willow wood and . . . harness spreader . . . [and] right there he make many good little knives . . . (1979: 266)

Binford provides a general description of the nature of tools that would be employed as "situational gear". That is, tools that are employed for specific tasks that arise in the course of events and that were not specifically anticipated and so specific tools were not prepared in advance:

> In general there is little investment in the tool-production aspects of "situational gear"; edges are used if appropriate, minimal investment is made in modification, and replacement rates are very high if material is readily available (1979: 267)

Most of the ethnographic information indicates that any modification to the flake tools is undertaken only if necessary and this is apparently seldom the case (Parry and Kelly 1987: 287). The two factors that would seem to dictate most whether a flake required modification or not are if a sharp edge needed to be blunted in order to protect the worker's hand or if the working edge required modification in order to make it more suitable for a specific task.

Perhaps the most common example of the latter situation would be when a flake

to be made more obtuse, and consequently, stronger and less sharp. This may not, however, be typically necessary in most situations for the simple reason that it may be easier to select a flake with a more naturally obtuse edge than to modify one to suit. As indicated in the quoted reference above (Miller 1979: 403), flakes are selected and tried out to determine their suitability to a specific task.

It seems possible that the majority of modifications made to simple flake tools may have been to protect the user's hand. If this is the case then many flakes that have been identified by North American archaeologists as retouched may have been examined on the wrong edge in the search for use-wear. These retouched flakes would be of the same category as those flakes referred to in Old World archaeology as "backed tools" (Frison and Bradley 1980: 85). It would require specific examination of both the retouched and unretouched edges of a flake to determine whether the retouch was likely use-edge modification or for user protection.

2.4.2 Archaeological Research

Current research into edge-damage on stone tools is several decades old (Hayden and Kamminga 1979) and many different approaches to the study of tool edge-damage have been taken. However, relatively few researchers have included unmodified flakes in their studies and even fewer have specifically focused on these. The majority of research has been oriented towards studying edge-damage on formal tool types such as biface tools and endscrapers. Some exceptions to this tendency include Brose (1975) who examined the role of the accumulation of animal fats in the formation of damage on unmodified flake tool edges; Walker (1978) and Howes (1980) who experimented with unmodified obsidian blades in butchering/animal processing tasks; Jones (1980) who compared the relative performances of unmodified flakes and Acheulean type handaxes in various butchering tasks; Bamforth (1985) and Frison and Bradley (1980) who carried out systematic and semi-systematic analysis (respectively) of utilized flakes from Early Prehistoric sites in the Southern Plains; Frison (1989) who experimented with marginally retouched flakes in butchering an elephant; and Young and Bamforth (1990) who questioned the usefulness and validity of the typical no-magnification identification of utilized flakes in archaeological assemblages.

While there are examples of research in which whole assemblages were examined under various levels of microscopy for traces of use-wear (e.g., Le Blanc 1984; Brose 1975), this invariably involves much time and often the use of expensive equipment. The excessive amount of time necessary to examine whole assemblages of debitage under a microscope and the potential difficulty and cost in accessing suitable microscopic equipment (Brose 1975: 87) are likely the main reasons why most lithic analysts tend to adopt the unaided visual inspection of debitage assemblages in the search for easily observable macroscopic edge-damage (Young and Bamforth 1990).

Experiments carried out by Young and Bamforth (1990) demonstrated the inaccuracy inherent in the unaided visual examination of debitage for evidence of use-damage. The experimentation involved asking nine different archaeologists, all members of the same department, but of different areas of expertise, to examine 11 flakes and determine whether or not they had been utilized and where on each flake the use-wear, if any, was located. "Only 36 out of 144 possible inferences (25%) were correct." The correct interpretations, not surprisingly, were most often associated with tasks that tend to produce more edge-damage. The other 75% errors included identifying unused/unaltered flakes as utilized, unused/altered flakes as utilized, and used flakes as un-utilized (Young and Bamforth 1990).

David Brose (1975) carried out two sets of experimentation in 1969 to 1971 and in 1972-73. These experiments were similar to those carried out in this study. While

Brose was not specifically attempting to determine the relative effectiveness of various levels of examination, this was one ancillary aspect of his research. In his initial experimentation he employed both high-power (300X Scanning Electron Microscope) and lower-powered (45X stereoscopic) microscopy to examine a set of experimentally produced utilized flakes. He began with the high-powered approach but, due to excessive preparation time, cost and the long actual laboratory time, he was forced to "revert to (the) less effective" lower-powered approach. He expressed disappointment in the effectiveness of this method in detecting use-wear on the experimentally utilized flakes. Initially he was only able to identify 20% of those flakes that had been utilized. With the use of surface staining and coating (MacDonald and Sanger 1968) he was able to increase the number of identifiably utilized flakes to 30-47% (Brose 1975: 88). However, he was employing flakes of obsidian, flint and chert and was relying on the detection of microscopic striations which Semenov (1964) had identified as the "proper" indications of utilization. It is anticipated in this study that striations would not be a particularly common nor easily visible type of edge-damage on utilized flake tools of raw materials with greater relative surface relief such as silicified siltstones and mudstones. It is expected that if striations were being formed they would occur on points of high relief which were separated by points of low relief resulting in incomplete, intermittent wear.

Most researchers tend to employ either obsidian or other "high quality" raw materials for the manufacture of experimental tools. Of those mentioned above, only Brose (1975: 93) and Frison (1989: 777) specifically addressed the issue of relative performance of different raw materials. While neither included clastic sedimentary raw materials in their experiments, Frison (1989: 777) notes that quartzite tends to hold an edge longer than chert. Brose states that the performance of flake tools of raw materials with lower surface relief (i.e. obsidian and chert) tends to be less negatively affected by the adherence of animal fats and consequently these tools may be used longer than tools of more granular raw materials (1975: 93). This is interesting as Frison (1989:777) notes that tools of materials with coarser lithology tend to remain effective, specifically for butchering, longer than tools of materials that are smooth-surfaced and Brose (1975: 93) suggests that because coarser-surfaced materials tend to acquire coatings of animal fats more readily they are not likely to be used for as long as tools of smoother surfaced materials. With regard to raw material as a factor in flaked tool studies, Brose (1975: 93) specifically states that "archaeologists can no longer afford to ignore different lithologies". While Brose made this statement over two decades ago, few lithic use-wear studies since then have satisfactorily addressed raw material as a factor in the formation of edge-damage.

In his second set of experiments, Brose (1975), again produced unmodified flakes, applied them to certain butchering tasks and then examined them under various levels of microscopy. In this case he indicates that 60% of the flakes had wear that was visible under low power and intimates that a greater number had wear that was visible under 300X, but does not supply the actual number or percentage (Brose 1975: 92).

The main argument of Brose's 1975 paper is that the adherence of animal fats to tool edges during butchering tasks inhibits the formation of edge damage and so obscures any patterns of actual usage in assemblages. However, in this second set of experiments, Brose, confines his experimentation to a single methodology in which the duration-of-use of each experimental flake was based only on the experimenter's feeling of a "loss of efficient function" (his quotation marks) or if the tool shape made it too awkward in a specific application. This is obviously subjective and considering that Brose also arbitrarily defined the tasks performed, it would be highly questionable to employ his resulting patterns and levels of edge-damage in comparisons to archaeological examples. Brose should have included individual tool-use episodes of various set durations to control for individual researcher-oriented biases. If prehistoric individuals employed individual flakes for durations different from those in Brose's experiments (ranging from 1 to 8 minutes) then the wear patterns produced by the interaction of the various factors (including animal fat adherence, raw material behaviour, and nature of butchering task) could be quite different.

Brose carried out this experimentation in response to attempts by other researchers to use the spatial distribution of flakes with different levels of use-wear to determine specific tasks areas at specific sites. A final criticism of Brose's experiments is that he apparently undertook his experimentation with the assumption that animal butchering would be the predominant edge-damage producing task carried out at any site in any time period and only gives passing note to the possibility that other tasks might also be carried out at a site (1975:93). However, Brose' research must be recognized as an early contribution demonstrating that the formation of edge-damage on tool edges is not straight forward and other potential factors exist beyond simply the level of hardness of the task material.

Another study, applicable to the questions in this research, was carried out by Bamforth (1985: 252-253). His analysis of the lithic debitage from eight small kill sites at Lubbock Lake, Texas, specifically questioned, as this thesis does, the preoccupation of Paleoindian research with formal tool technology. He employed various levels of microscopy in the analysis of the debitage from these sites and identified 107 retouched or unmodified flake tools out of 266 items of debitage.

Chapter 3 Archaeological Sites

Assemblages from three archaeological sites were selected as case studies against which the results of the use-wear experimentation could be tested. The three sites are located within the front ranges of the Alberta Rockies. One site, 243R, is located at the north end of Jasper National Park and the other two, 1626R and EkPu-8, are in close proximity to each other just outside the north boundary of Banff National Park in the Upper Red Deer River region (see Figure 3.1). All three are multi-component sites the earliest occupations of which have been established, through radiocarbon dating, to be Early Prehistoric in age.

3.1 Site 243R

3.1.1 Site Description

Site 243R is located on an elevated bench on the north side of the Snake Indian River near the confluence of this river and the Athabasca River in Jasper National Park (Figures 3.1 and 3.2). This elevated bench, likely the remnant of a lateral moraine, is 50 to 75 meters above the present river level. The till formation that forms the bench extends west along the north side of the Snake Indian River, from the Cascade Road bridge, continuously for approximately one to one and a half kilometers. Currently, access from the top of the bench to the river is not easy and involves descending a precipitous slope of glacial till. Site 243R is located at the very east end of this formation, although archaeological materials have been noted at several locations along the erosional face of the bench and other sites have been tested and given official Parks Canada designations (Hudecek-Cuffe 1997).

Currently the area is typical Rocky Mountain montane environment with various grasses and creeping juniper (*Juniperus horizontalis*) being the dominant ground cover. Shrubs in the area include wolf willow (*Elaeagnus commutata*), kinnikinnik (*Arctostaphylos uva-ursa*), and buffalo berry (*Sheperdia canadensis*). Tree cover is intermittent on the slopes and consists of spruce (*Picea* spp.) and poplar (*Populus* spp.) while along the river edge is found more poplar with some willow (*Salix* spp.) and occasional white birch (*Betula papyrifera*) (Hudecek-Cuffe 1997).

Fauna common to the area today include: mule deer (*Odocoileus hemionus*), white tail deer (*Odocoileus virginianus*), elk or wapiti (*Cervus elaphus*), moose (*Alces alces*), bighorn sheep (*Ovis canadensis*), possibly caribou (*Rangifer tarandus*), black bear (*Ursus americanus*), grizzly bear (*Ursus arctos*), wolf (*Canis lupus*), coyote (*Canis latrans*), small mammals ranging in size from porcupines (*Erethizon dorsatum*) to chipmunks (*Eutamius* sp.) and mice, and various species of birds common to the Eastern Slopes.

Parks Canada Archaeological Services personnel, through surface surveys in 1983, recognized the archaeological potential of this landform. Cultural material was noted eroding out of the active edge of the landform and several activity foci or "sites" were recognized along its length (FgQm-59; Archaeological Survey Archaeological Site Inventory Data Form 1983).

Limited subsurface shovel testing was carried out by Peter Francis and a small Parks Canada Archaeological Services crew in 1993 (Site 243R Parks Canada Western Region Archaeological Services Site Visit Form, 1993). It was recognized that the ongoing erosion of the bench face was rapidly compromising the integrity of the buried cultural materials on the bench. The Snake Indian River Threatened Sites Project was then begun. Detailed excavations were started in 1995, again, under the direction of Peter Francis, staff archaeologist. Eight 1x1 units were excavated through 1 to 1.25 meters of aeolian silts down to glacial till. At this time at least four cultural components were recognized. Cultural materials recovered were predominantly lithic remains and a small quantity of fire-broken rock. One projectile point base was recovered but was not intact enough to be reliably assigned to any specific typology.

In 1996 Parks Canada Archaeological Services and the Department of Anthropology from the University of Alberta began a joint excavation project at this site in the form of an archaeological field school under the direction of Caroline Hudecek-Cuffe. The field school was conducted again in 1997 and is scheduled to operate again in 1998. The author has served as a teaching assistant for the field school since its inception.

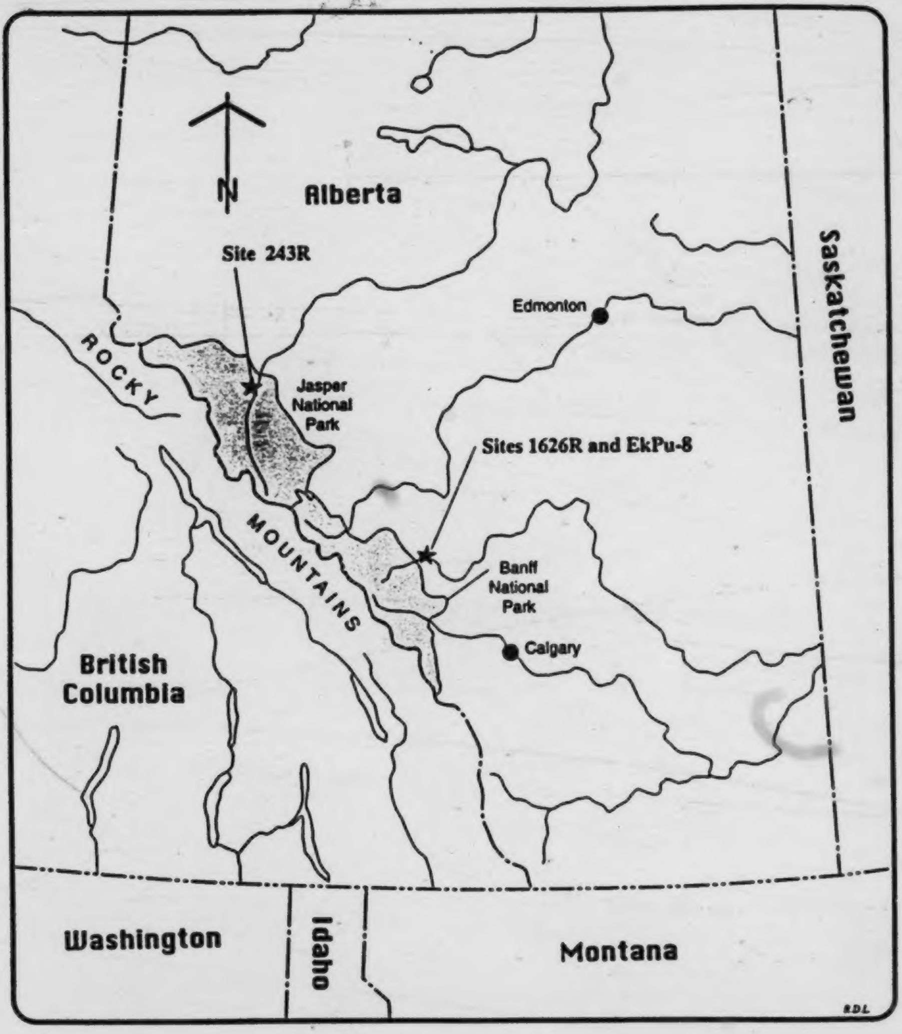


Figure 3.1 Map of Southern Alberta Showing Locations of Three Sites Included in Study

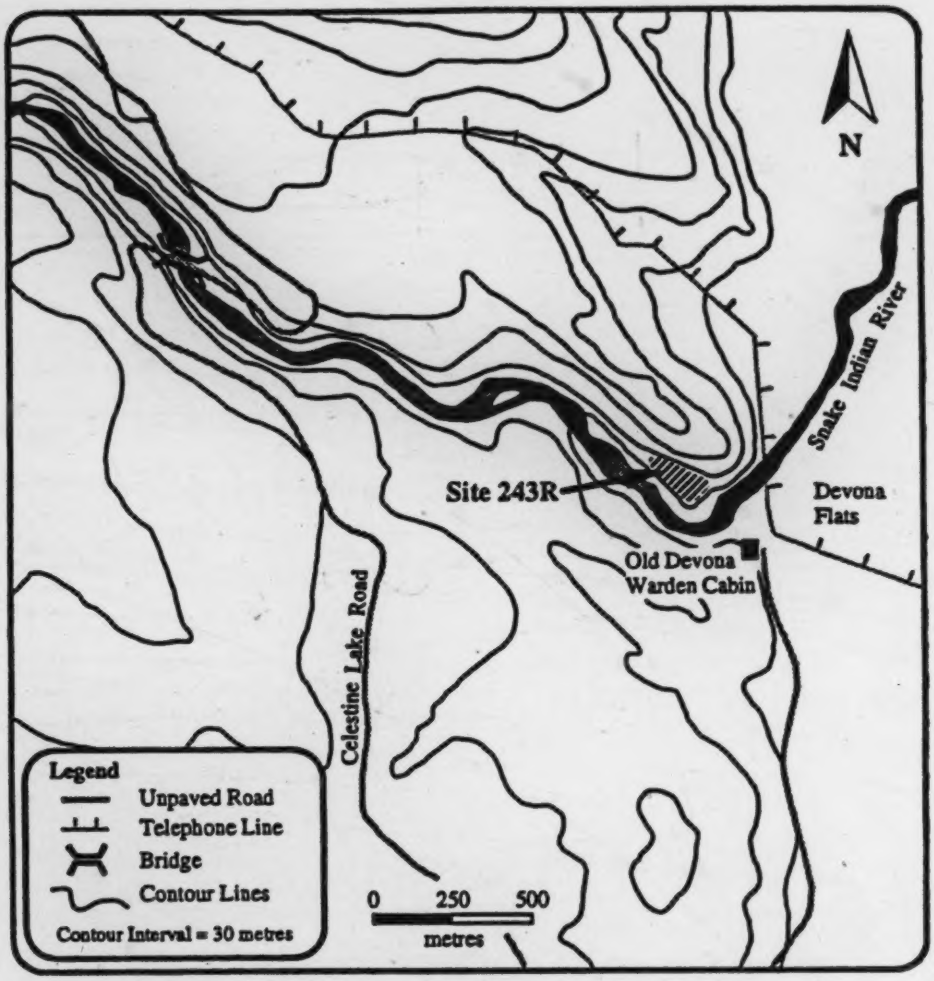


Figure 3.2 Site 243R and immediate surrounding area along the Snake Indian River in the North end of Jasper National Park, Alberta (Map courtesy of Caroline Hudecek-Cuffe 1997).

In 1996 and 1997 a total of 19, 1x1 meter, units were begun. At the end of the 1997 season, nine units had been completed (excavated to till) and six others were nearly completed (Hudecek-Cuffe 1998).

3.1.2 243R Natural and Cultural Stratigraphy

The supra-glacial sediments at site 243R are predominantly aeolian silts interspersed with occasional pieces of colluvium from the slope above the bench. The stratigraphy below circa 40 centimeters is relatively distinct. Above 40 centimeters it is less clear and there may have been a certain degree of natural disturbance, such as cryoturbation or bioturbation, in the past. None of the volcanic tephras that might occur in this area (e.g., Mazama ash or Bridge River ash) have been identified in the stratigraphy and the limited quantities of datable materials from unquestionable cultural contexts have resulted in the chronologic control at this site being less well established than for the other two sites used in the study. Some radiocarbon dates have been returned on charcoal from several different layers but these must be viewed with an understanding of the contexts from which they were recovered. Much of the charcoal material encountered in the sediments at this site is likely the remains of human activities. However, throughout the excavations charcoal was routinely encountered in the form of "root burn". Root burn occurs during or following forest fires when the roots of a burned tree continue to smoulder for some time beneath the ground surface.

While charcoal resulting from natural events can provide valuable chronologic information, root burn, by its very nature, occurs in stratigraphic layers that are older than the ground surface at the time of the actual burn event. This means that dates derived from root burn charcoal are always vague chronologic markers, although, they can provide rough minimum ages for sediments stratigraphically below the dated root burn.

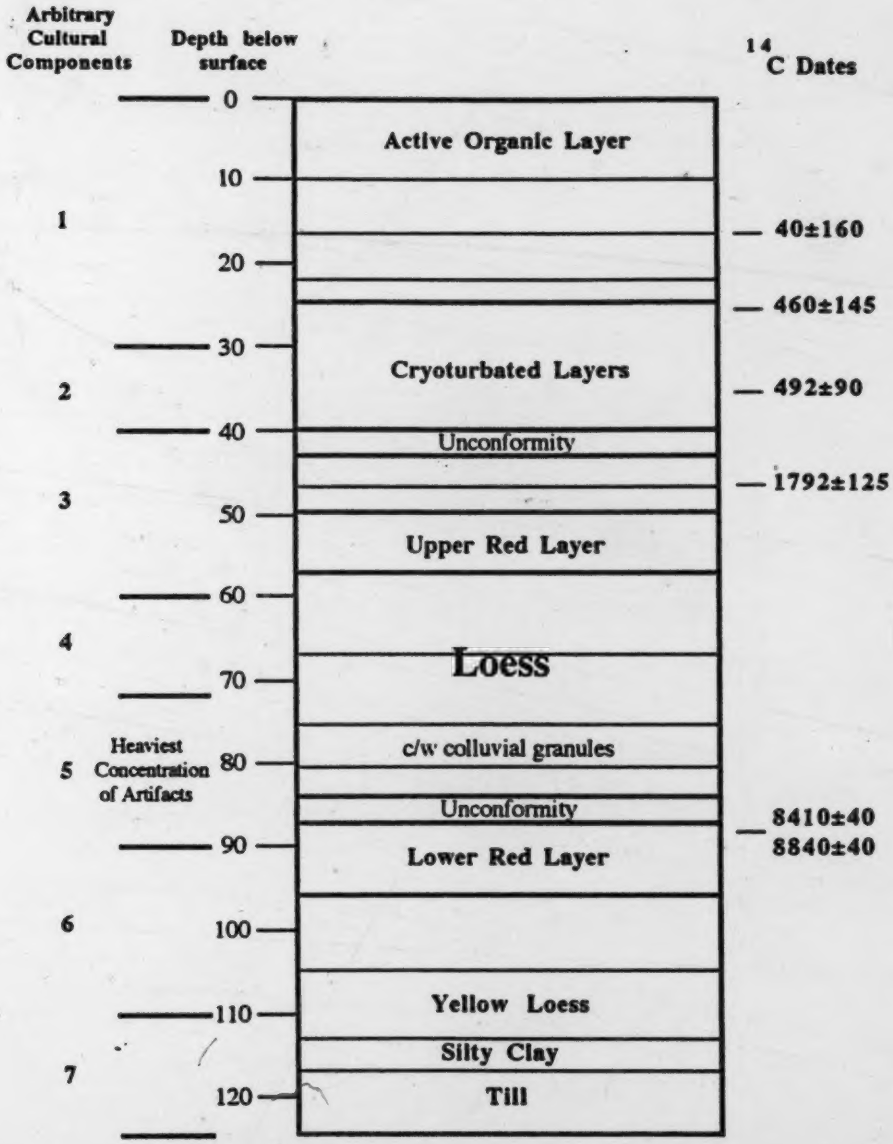


Figure 3.3 Composite Stratigraphy of Site 243R, Snake Indian River, Jasper National Park (courtesy Alberto Musaccio).

Cultural components have been difficult to define. The work carried out at the site so far has indicated that defining discrete cultural components that would be present throughout the site would not be an accurate depiction of the nature of the use of the site throughout the Holocene. Rather than discrete periods of occupation of the whole site separated by periods of abandonment, a more accurate description might be of a relatively continuous use of the site in the form of very short term occupations in which each involved use of only a small portion of the whole site area. If a profile drawing were made of the entire site stratigraphy, rather than having several horizontally continuous bands, representing periods of occupation, separated by sterile sediments, a better depiction would be of many individual lenses that are discretely dispersed horizontally as well as vertically.

Because of the nature of the cultural deposits, and in order to allow analysis of diachronic variation in the cultural materials, the deposits were divided into arbitrary vertical units. In the placement of these arbitrary boundaries, an attempt was made to maintain the integrity of as many of these discrete lenses of cultural material as possible (Hudecek-Cuffe 1998 - report in progess).

Level 1 (0 to 30 centimeters below surface)

Eighteen artifacts were recovered from this level. Two radiocarbon dates were acquired on charcoal. The first was 40±160 radiocarbon years BP (0 years BP/present calibrated - BGS 1923) and the second was 780±120 radiocarbon years BP (720±120 calibrated - BGS 2032).

Level 2 (30 to 40 centimeters below surface)

Twenty-two artifacts were recovered from this level. Two radiocarbon dates were acquired on charcoal. The first was 460±145 radiocarbon years BP (510±145 calibrated - BGS 1924) and the second was 492±90 radiocarbon years BP (520±90 calibrated - BGS 1925).

Level 3 (40 to 60 centimeters below surface)

Approximately 650 artifacts were recovered from this level. One radiocarbon date was returned on charcoal from a depth of 43 centimeters at 1792±125 radiocarbon years BP (1710±125 calibrated - BGS 1926).

Level 4 (60 to 72 centimeters below surface)

Approximately 1200 artifacts were recovered from this level. Two radiocarbon dates were acquired on charcoal. The first was 2648±80 radiocarbon years BP (2770±80 calibrated - BGS 2031) and the second was 2590±85 radiocarbon years BP (2750±85 calibrated - BGS 2033).

Level 5 (72 to 90 centimeters below surface)

Approximately 3350 artifacts were recovered from this level. No radiocarbon dates were obtained for this level.

Level 6 (90 to 110 centimeters below surface)

Approximately 100 artifacts were recovered from this level. No radiocarbon dates were obtained for this level.

Level 7 (110 to 120 centimeters below surface)

Seven artifacts were recovered from this level. Two AMS radiocarbon dates were obtained from charcoal from approximately 120 centimeters below surface. This charcoal was suspected at time of recovery to be the result of root burn and so likely younger in age than the deposit it was found in. The first date was 8840±40 radiocarbon years BP and the second was 8410±40 radiocarbon years BP.

3.2 Site 1626R

3.2.1 Site Description

This site is located on the west side of Scalp Creek near the centre of the Ya-Ha-Tinda Ranch which is located near the northeast boundary of Banff National Park on the Upper Red Deer River (see Figures 3.1 and 3.4). The Ya-Ha-Tinda is a relatively unique ecozone in the Eastern Rockies. While technically montane it is essentially a grassland due to the relatively low relief of the area and a localized precipitation shadow (Morgantini 1995). In general the flora and fauna here are very similar to that described above for the lower Snake Indian River with, however, less overall tree cover within the ranch area itself. The surrounding mountain slopes do have typically heavy tree cover with mixed deciduous and conifer at lower elevations and predominantly conifers higher up the slopes. The prairie-like nature of the area has encouraged a greater presence of grazing animals and the growth of very large elk populations (currently about 2500 to 3000 animals) is a current issue in the management of the ranch area. Other, typically prairie species such as badgers (Mustelidae) also distinguish the Ya-Ha-Tinda from other mountain regions. Bison (*Bison* spp.) remains occur in the archaeological record here and may well have had a greater presence here prehistorically than might have been typical in other areas of the Alberta Rockies (Darwent 1995).

Scalp Creek runs generally northwest to southeast through the central area of the ranch before entering the Red Deer River which is the south boundary of the ranch. Through much of the creek's course, it truncates the southwestern edge of a raised landform creating a length of relatively high southwest facing cutbanks. The cross-section of this landform, created by the cutting of the creek, exposes a lower bedrock formation of Cretaceous age shales overlaid by Wisconsinan age glacial till (Pheasant 1968; Morgantini 1995). The till is topped by a 1-1.5 meters of aeolian silts and volcanic tephras. The edge of this cutbank provides an excellent vantage point from which the area of the ranch to the southwest (the area of lowest elevation) can be surveyed.

Archeological investigations began in the early 1970s in the Upper Red Deer River region (Elliot 1971). This early work involved mainly surface surveys with occasional limited subsurface shovel testing. Several dozen prehistoric sites were recorded. Investigations in the late 1980s relocated many of Elliot's sites, identified several more, and involved some more detailed excavation, particularly along Scalp Creek (Fedje 1987). In the course of this work it was realized that the rapid erosion occurring along the eastern edge of Scalp Creek was damaging archaeological sites and archaeological material and information were being lost at a rapid pace. This instigated the Scalp Creek Threatened Sites Project which began in 1992 under the direction of Francis. Excavations were carried out at seven sites along Scalp Creek in 1992-1994 and again in 1996 (Francis 1997). Archaeological materials appear to be more or less continuous in occurrence both temporally and spatially along the cutbank edge and the delineation of individual sites along the landform is probably best described as arbitrary.

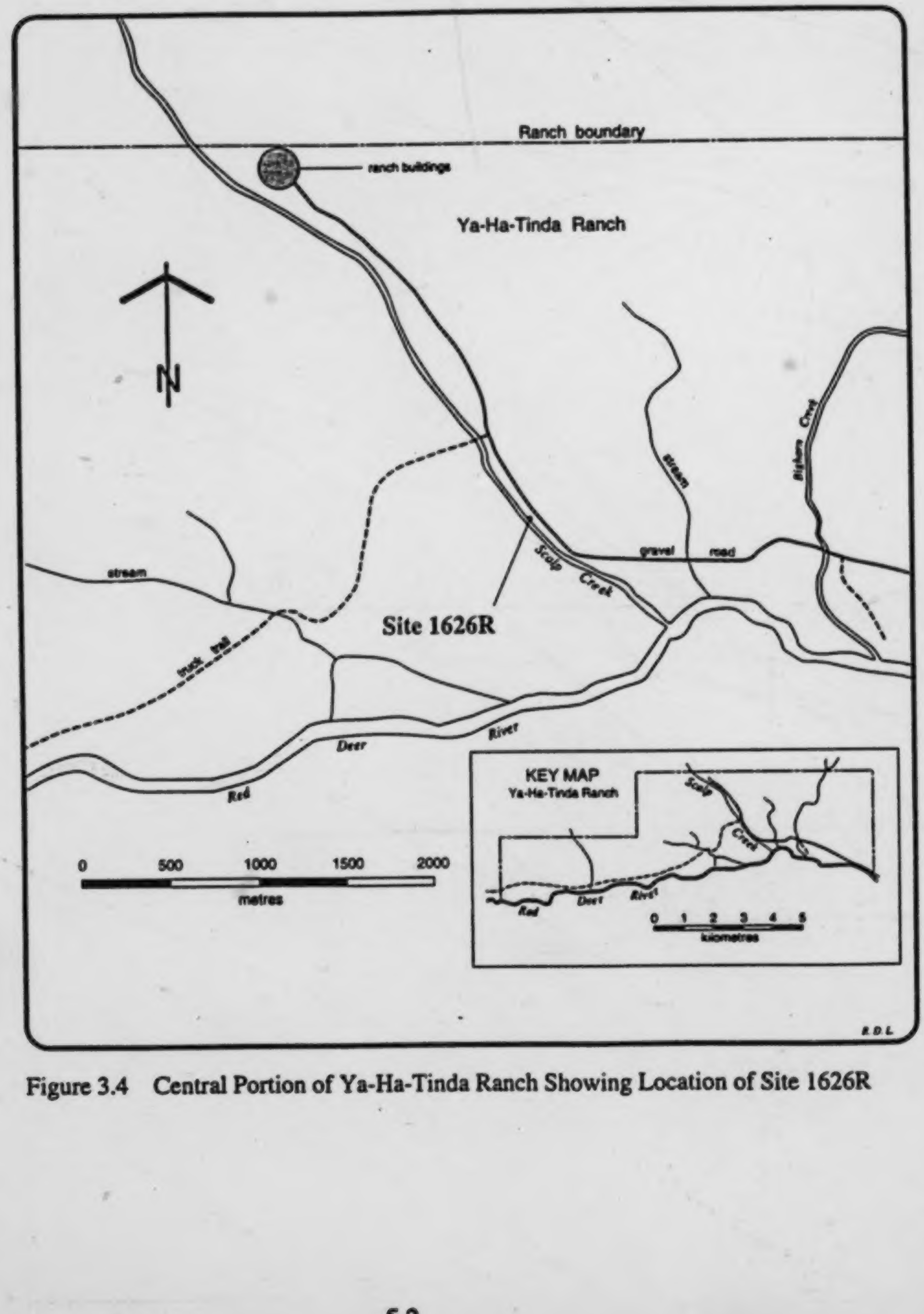


Figure 3.4 Central Portion of Ya-Ha-Tinda Ranch Showing Location of Site 1626R

Site 1626R is intersected by the present edge of the cutbank and its presence was first noted due to lithic and bone materials eroding from the cutbank (see Figure 3.5). A total of 40, 1x1 meter, units were excavated at site 1626R between 1987 and 1996. Site 1626R is one of the more extensive sites along Scalp Creek with nine obvious prehistoric components and has undergone the most excavation and analysis. Why this particular location, now designated site 1626R, rather than any other locations in one direction or the other along the landform, was a more popular location for habitation throughout the Holocene is not evident at this time. Perhaps in the past, before the erosional face reached its present state, access to the creek was better at this location than elsewhere along the cutbank. Other, equally plausible, reasons could also be suggested but would also be equally speculative at this point.

3.2.2 Site 1626R Natural and Cultural Stratigraphy

The supra-glacial stratigraphy along the landform is quite clear and the volcanic tephras and (uncalibrated) radiocarbon dates from site 1626R provide good chronologic control. Unfortunately very few diagnostic artifacts were recovered. Fourteen distinct major stratigraphic layers were identified at site 1626R (Figure 3.5). The distinction between these layers was based mainly on sediment colour and texture.

Layer 1 is a thin Ah horizon in which the surface sod is rooted. Very few artifacts were recovered from this layer but the presence of some resulted in its designation as Cultural Layer IX.

Layer 2, below the Ah horizon, is a thicker (10 to 20 cm) layer of dark brown silty loam from which no cultural materials were recovered.

Layer 3, below the dark brown loam, is a thin (5 cm) black horizon, possibly a palaeosol. This layer included faunal remains, heavily concentrated in some locations of the site, and limited lithic materials. Two radiocarbon dates on bone collagen were returned at 800±50 and

		^{14}C & Tephra Dates
1	**Black Ah (sod)**	
2	**Dark Brown Silty Loam** No cultural material 10 to 20 cm thick	
3	**Black Horizon** Palaeosol? ci. 5 cm thick	800±50 935±70
4	**Grey-Brown Silt** 5 to 10 cm thick	
5	**Light Brown Silt** 5 to 10 cm thick	
6	**Black Horizon** Palaeosol? 2-3 cm thick	
7	**Upper Tephra** Bridge River @ 2350BP ci. 2 cm thick	2350 BP
8	**Medium Brown Silt** ci. 5 cm thick	2890±40 3940±60
9	**Black Horizon** Palaeosol? ci. 5 cm thick	5570±60
10	**Reddish-Brown Silt** ci. 5 cm thick	
11	**Lower Tephra** Mazama Ash @ 6850BP 5 to 10 cm thick	7130±60
12A	**Red Clay** ci. 5 cm thick	9330±70
12B	**Grey Clay** ci. 5 cm thick	
13	**Black Clayey Silt** c/w Glacial till directly below	

Figure 3.5 Composite stratigraphy of Site 1626R along the east side of Scalp Creek on the Ya-Ha-Tinda Ranch, Alberta.

935±70 radiocarbon years BP (BGS 1784), putting the age of this component within the Late Prehistoric Period. This was designated as Cultural Layer VIII.

Layer 4 is a layer of grey-brown silt (5 to 10 cm) from which no cultural materials were recovered.

Layer 5 is a light brown silt and is of a similar thickness to layer 4. While some cultural materials were recovered and this layer was designated as Cultural Layer VII, no diagnostic artifacts or datable materials were recovered.

Layer 6 is another black horizon, possibly a palaeosol. A small number of artifacts were recovered and this layer was designated as Cultural Layer VI.

Layer 7 is a very thin lense of white powdery sediment that has been tentatively identified as Bridge River Ash from the eruption of Meagre Mountain in southwest British Columbia dated at 2350 B.P. This layer, if it is Bridge River Ash, provides a useful stratigraphic boundary with the Late Prehistoric above it and the Late Middle Prehistoric below it.

Layer 8 is thin layer (5 cm) of medium brown silt. This layer was designated as Cultural Layer V and two AMS dates were returned on bone collagen from this layer. These were 2890±40 and 3940±60 BP (CAMS 12912).

Layer 9 is a third black horizon (5 cm) given the designation of Cultural Layer IV. This may be another palaeosol. A radiocarbon date on bone collagen was returned at 5570±60 radiocarbon years BP.

Layer 10 is a thin layer of reddish-brown silt with no cultural materials.

Layer 11 is a second tephra (tentatively identified so by its powdery nature and buff colour) and occurs below the reddish-brown layer. A similar sediment in the adjacent James Pass has been positively identified as Mazama Tephra (Beaudoin 1996) from the eruption of Mount Mazama (Crater Lake) in Oregon which has been well dated to 6850 BP (Bacon 1983). This layer represents a mixture of aeolian silt and presumably redeposited tephra and contains some cultural materials. Two questionable dates (given their stratigraphic association with a well dated tephra) were returned on bone collagen from this layer at 5110±70 and 5420±60 radiocarbon years BP. A third AMS date was returned at 7130±60 BP (CAMS 12911) which fits well with the age of the associated Mazama tephra. This layer was given the designation of Cultural Layer III.

Layer 12, below the tephra, was a layer of heavy red and grey clays. In some locations these two clays were mixed together as if they had been disturbed when they were at ground surface. In other locations they were relatively distinct with the red clay always stratigraphically above the grey. In these locations the red clay is designated Layer 12a and the grey clay is Layer 12b. One AMS radiocarbon date of 9330±70 BP (CAMS 19728), was returned on bone collagen from 12a. Layer 12 was designated Cultural Layer II.

Layer 13 is the lowest layer above the till. It is a black clayey-silt with rare, but occasional cultural material. This layer was designated of Cultural Layer I.

3.3 Site EkPu-8

3.3.1 Site Description

Site EkPu-8 is approximately six or seven kilometers due east of the Scalp Creek sites in the James Pass directly adjacent to, and to the east of, the Ya-Ha-Tinda Ranch. The James Pass is a relatively small pass, running east and west, just to the north of the much larger Red Deer River corridor (Figure 3.1 and 3.6). James Pass connects the Ya-Ha-Tinda area within the front ranges to the the foothills and plains to the east and may well have served as an easily traversable transportation route between these two regions prehistorically. Currently the pass serves as an important seasonal migration route for large elk populations.

The flora and fauna of the James pass is, not surprisingly so, very much the same as that in the Ya-Ha-Tinda area and in the Snake Indian River region. The pass or valley bottom is clear open grassland at the western end above mainly fluvial sediments from small streams coming off the north valley slopes. Mixed deciduous and conifer forest begin very near the bottom of the valley slopes. This forest is dominated by the conifers and becomes more so further up the slopes. To the east the pass is less open, containing a series of small lakes connected by marshy

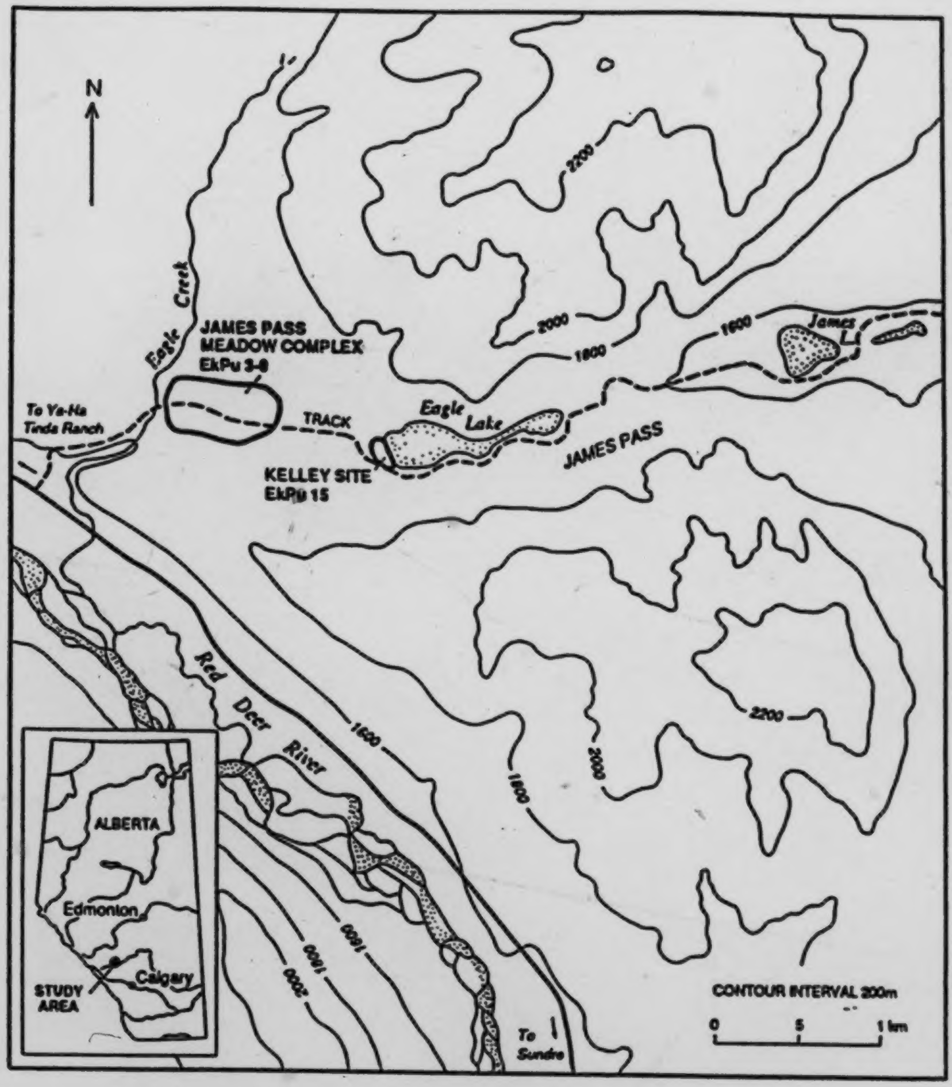


Figure 3.6 Site EkPu-8 within the James Pass Meadow Complex of associated sites in the James Pass, Alberta. Site 1626R is located several kilometers west of the James Pass Meadow Complex. (Map courtesy of Brian Ronaghan and Archaeological Survey, Provincial Museum of Alberta).

sections with the tree line beginning right at the water's edge. Currently, foot travel along the edges of these lakes is not difficult.

Little or no serious archaeological investigations had been carried out in the James Pass prior to 1990. Over the past several decades a deeply rutted track had been created by four-wheel drive vehicles accessing the valley for hunting and fishing purposes. These deep tire ruts have brought to the surface vast quantities of lithic remains, fire-broken rock, and faunal materials. In 1989, staff from the Archaeological Survey, Provincial Museum of Alberta, were shown a private collection of artifacts recovered from surface contexts in James Pass. Among the collection were large projectile points clearly belonging to the Early Prehistoric Period, including one that readily falls into the Folsom typology (Ronaghan 1993: fig. 1). This finding instigated serious field investigations by members of the Archaeological Survey, under the direction of Ronaghan, beginning in 1991. The 1991 investigations led to the recognition of eight sites. One of these is the Kelley Site (EkPu-15), located at the west edge of Eagle Lake, the western most of the series of lakes. The other seven sites were located in the very west end of the pass and are collectively referred to as the James Pass Meadow Complex. Field work carried during the period from 1992 to 1994 focused on site EkPu-8, which is part of this complex of sites.

Site EkPu-8 is located within a small unique landform on the north side of the pass and at its western end. This landform is a raised finger of bedrock that curls out from the north slope of the pass creating a small sheltered basin behind it. This shallow basin area, approximately 20 to 30 meters in diameter, provides shelter from the wind and would have provided an excellent vantage point from which an individual could surveyed the open valley terrain without being seen.

In 1996 the Archaeological Survey, Provincial Museum of Alberta, carried out some remote sensing investigations over a large area of the western meadow in the hopes of detecting further, more deeply buried, sites. This investigation, however, turned up very little in the way of potentially promising leads.

3.3.2 EkPu-8 Natural and Cultural Stratigraphy

Between 1992 and 1994 a total of 20, 1x1 meter, units were excavated at EkPu-8. All were taken down to bedrock, which occurred at approximately 90 centimeters below surface in this location. The natural stratigraphy is quite distinct with nine major identified sedimentary units within which six cultural layers were recognized. Occasional fragmentary pieces of bone were recovered and provided radiocarbon dates which, along with the tephras, provided good chronologic control for the stratigraphic sequence (Figure 3.7).

The uppermost sedimentary unit is a black Ah layer which includes the surface sod cover; no cultural materials were recovered from this unit.

Below the Ah layer is a thicker layer of mottled Ab/black loam. Near the bottom of this was a thin white powdery lense tentatively identified as Bridge River tephra (Beaudoin 1996) dated to 2350 BP (see description above). This layer was designated Cultural Occupation Layer VI. Artifacts from this component included lithic debitage and side-notched projectile points typical in form of Besant points of the Late Middle Prehistoric period (2000 to 1150 BP; Vickers 1986).

Below the mottled Ab is layer of reddish brown silt referred to as the Upper Red and designated Cultural Occupation layer V. Artifacts again include lithic debitage and projectile points. Late Middle prehistoric side-notched styles continue in the upper portion of Layer V and Middle Prehistoric side-notched styles, typical of the Early Mummy Cave Complex (7500 to 3500 BP; Reeves 1975), occur in the lower portion.

Below the Upper Red is a layer of very fine silty sediments of a buff colour. This sediment has been identified as Mazama tephra (Beaudoin 1996) which is well dated to 6850 BP (Bacon 1983 - see description above).

Directly below the Mazama layer is a thin lense of black, richly organic, sediments with very heavy concentrations of lithic materials. This layer was designated Cultural Occupation layer IV and is suggested to be a living floor. It contained, by far, the greatest concentration of artifacts. Projectile points recovered from this layer included more side-notch styles typical of the Early Mummy Cave Complex as well as several examples of a unique style of side-notched point for which previously define stylistic affinities cannot be found. This new style has been officially termed the "James Pass Longneck" (Dawe and Ronaghan 1997). A radiocarbon date was returned for this layer of 7665±150 BP.

Below the living floor is a thick layer of red silty clay referred to as the Lower Red and designated Cultural Occupation layer III. Artifacts included lithic debitage and fragmentary ***Bison*** sp. remains. An AMS radiocarbon date of 9750±80 BP (TO-2999) was returned on bone collagen.

Below the Lower Red was a thin layer of light brown clay with sandstone rubble. This was designated Cultural Occupation layer II. Three AMS radiocarbon dates on bone collagen include one at 9990±80 BP, one at 9990±60 BP, and one at 10120±40 BP (TO-3000). Artifacts recovered include, besides debitage, a Llano-type basally-thinned lanceolate point base.

A layer of grey-brown clay occurred below the light brown and was designated Cultural Occupation layer I. Artifacts recovered from this layer did not include any diagnostic projectile points or datable materials, but, along with some debitage, there was recovered a large blade-like flake (ca. ten centimeters long by four centimeters wide) with extensive unifacial retouch along one entire margin.

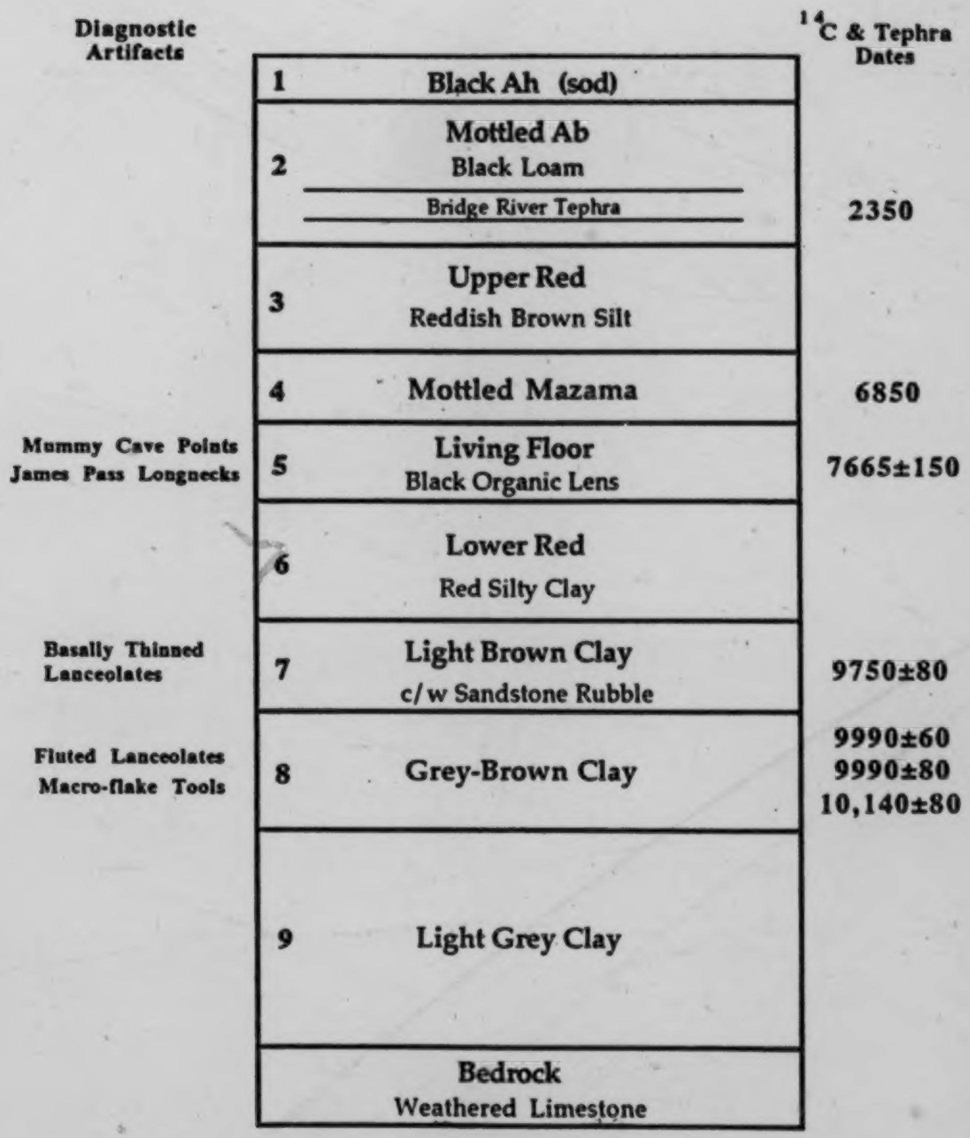


Figure 3.7 Composite stratigraphy at Site EkPu-8 in James Pass, Alberta (data courtesy Brian Ronaghan of the Archeological Survey, Provincial Museum of Alberta).

Chapter 4 Archaeological Samples

4.1 Theoretical Criteria for Selection of Unmodified Flake Tools

In interpreting prehistoric use of unmodified flake tools two major criteria are identified here that, to varying degrees, undoubtedly factored into an individual's selection of a flake for a specific application. These are size and edge morphology. The nature of the task at hand will, in most cases, dictate certain parameters for these criteria. In some specific situations, such as a task that required a long working edge, these two criteria may be directly related. In other cases, either one or the other may be of greater importance to the specific task at hand.

4.1.1 Size

The most obvious part that flake size might play in selection criteria would be in the ease and comfort of handling and the ability to bring to bear the necessary pressure of tool edge to task material. The smaller the flake the more difficult it can be to apply it with sufficient pressure to a task material. It may be difficult to draw a line here between comfort preference and functionability and in some cases the former may affect the latter so that they become indistinguishable. In a task such as carving wood where a relatively high level of applied pressure may be necessary, a larger flake would seem preferable because it would allow a more solid hand grip. It seems logical that for any task, other factors aside, a larger flake would be most preferable because it would provide a more solid and more comfortable grip. Figure 4.1 provides a graphic illustration of actual flake sizes that allow a more accurate visualization during discussions of size.

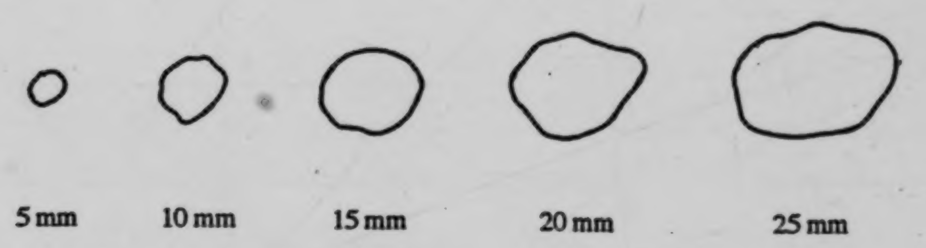


Figure 4.1 Graphic examples of various actual flake sizes.

The possibility that unmodified flake tools were hafted must also be considered. However, it would seem reasonable to expect size to be a factor in the selection of suitable flakes in this circumstance as well. Rather than comfort of handling, the problem with hafting would be using a flake that was large enough to be hafted securely enough to withstand applied pressures.

4.1.2 Edge Morphology

Size may not always be the initial deciding criteria. Different tasks will require different types of working edges. Both edge angle and spine-plane angle are potentially important aspects of edge morphology. Edge angle is the angle of the junction of the dorsal and ventral surfaces back 1 mm from the edge. Spine-plane angle is the angle of the junction of the dorsal and ventral surfaces over the whole cross-section of the flake from the edge (Hayden and Kamminga 1979). The terms acute and obtuse are applied here in a casual manner rather then in the strict sense in which acute refers to less than 90 degrees and obtuse refers to greater than 90 degrees. In the discussions that follow the term acute tends to be applied to edge angles 45 degrees or less and obtuse tends to be applied to edges with angles of approximately 45 degrees or greater. Through most of the following discussion angles are referred to in relative terms such as more acute or more obtuse.

Certain cutting tasks *tend* to be better performed with tools with edges and spine-planes with more acute angles, while tools with more obtuse edge angles and spine-planes *tend* to work better for scraping tasks. These are functional dictates based on whether the task requires the insertion of the tool edge into the task material or whether the task requires the separating of connected material(s) through a shearing action across the material surface. In the former, a sharp edge is more important than lateral edge strength, while in the latter lateral edge strength is more important than acuteness of the working edge. These are not, however, absolutes. In cutting tasks where the the tool edge is only working the very surface of the task material and is not being pushed deeply into the material (i.e., wood carving) then an acute spine-plane angle may be less of a necessity than in cutting tasks where the tool edge is biting deep into the material (i.e., butchering meat or cutting tubers).

Length of working edge is another important characteristic. Certain tendencies with respect to this were noted during the experiments carried out in this study. Tasks such as cutting meat or tubers will tend to require an edge with some length to it. A longer working edge allows swifter and more efficient cutting motions as fewer strokes tend to be required to carry out a specific amount of work. The person using the tool is not required to spend as much of the time, energy, or concentration necessary in constantly returning the tool's working edge to the point of separation of the task material. For other tasks, like carving or whittling, in which detailed and complex manipulation of the task material may be intended and long strokes may not be required, a shorter working edge or, in fact, a sharp point may be preferred over a long edge.

A third aspect of edge morphology is the plan view morphology of the edge. The plan view of an edge may be described as straight, concave, or convex in general shape. The plan view shape of an edge may also be an important criterion in tool selection for different tasks. A good example would be the use of a relatively deep concave edge for scraping and smoothing wood for projectile shafts like spears or atlatl darts.

4.2 Selection of Archaeological Samples

The population from which the sample flakes were selected, from each site in the study, was defined based on assemblage age, raw material type, flake size, and the presence of an edge that would seem suitable for application to one or more perceived tasks. Therefore, any conclusions or interpretations made based on patterns observed in the samples are only applicable to the flakes which satisfy these criteria, as they are defined below.

All the flakes that had been identified as utilized in the initial analysis of the three sites were excluded from the populations as well and, therefore, none were included in the samples analyzed in this study. They were included in the summaries of utilized flakes for the three sites. Totals of the identified utilized flakes, as illustrated in several tables below, include those identified in the initial site analyses and those identified in this study.

The sample of flakes selected for analysis from the Middle Prehistoric components of the three study sites is less then 10% of the total population. This prevents any formal extrapolation of patterns observed in the sample to the population as a whole. The sample from the Middle Prehistoric assemblages cannot be viewed as representative of the total population as it is less than 10% of the defined population (Thomas 1976). The Middle Prehistoric assemblages were, however, included as a minor aspect of the thesis for purposes of comparison to the Early Prehistoric/Paleoindian period debitage.

4.2.1 Age of Assemblages

The temporal scope of this thesis was intended from the outset to include mainly the Early Prehistoric/Paleoindian Period (c. 12,000 to 8000 years BP in the Northern Plains culture-historic sequence). The majority of items in the three samples is comprised of debitage from the Early Prehistoric Components. However, in order to provide data for potential analysis of diachronic patterns, some Early Middle Prehistoric (c. 8000 to 5000 years BP) aged debitage from the three archaeological assemblages was also sampled. For two of the archaeological assemblages, EkPu-8 and 1626R, relatively good chronologic control has been established. This allowed a confident separation of Early Prehistoric and Middle Prehistoric components and assemblages. Chronologic control for 243R stratigraphy is, currently, less than favourable, but a "best guess" was made to distinguish between Middle and Early Prehistoric assemblages.

4.2.2 Raw Materials

Samples included only debitage of clastic sedimentary raw materials (siltstone, mudstone, silicified siltstone, and silicified mudstone). For the Middle and Early Prehistoric components of all three archaeological sites, this resulted in the exclusion of only minor portions of the assemblages (see Tables 4.1, 4.2, 4.3, 4.4, 4.5, and 4.6). Clastic-sedimentary raw materials comprised 94.5% of the Site EkPu-8 debitage assemblage, 85.1% of the Site 1626R debitage assemblage and 85% of the Site 243R assemblage. However, of the cryptocrystalline materials recovered from Site 243R, 95% were from a single concentration of very small chalcedony debitage that was undoubtedly the result of the final stage in the production of a formal tool. All this chalcedony debitage was ≤ 10 millimeters and the majority (83.0%) were actually ≤ 5 millimeters in maximum dimension. With these items excluded from the total assemblage (due to the impossibility of their use as unmodified flake tools), debitage of clastic sedimentary materials comprise 94% of the remaining Site 243R assemblage.

Several large flakes of clastic sedimentary materials in each assemblage were not included in the samples because of raw material "quality". Most of these flakes were quite large and may well have been utilized but were of a poorly consolidated clastic material the edges of which tended to crumble quite easily compared to the silicified varieties (bringing their serviceability for most tasks into serious question). It is possible that at the time that they were produced these flakes were harder and more serviceable and that over millennia of being buried in sediments that constantly varied in moisture content, they deteriorated in degree of consolidation. Regardless of the original condition of these items, at present their edges damage in such a way that it is difficult, at best, to distinguish possible genuine use-wear from natural weathering.

Table 4.1 Summary of Artifact Types and Raw Materials Recovered from Cultural Unit 5 (Early Middle Prehistoric Component) of Units 8N, 28W and 8N, 29W at EkPu-8 (Archaeological Survey, Provincial Museum of Alberta - unpublished data).

Artifact Type	silicified sedimentary	non-silicified sedimentary	quartzite	crypto-crystalline	other	Totals
Cores	0	0	0	0	0	0
Debitage	136	8	9	7	0	160
Tools	2	0	0	0	0	2
Totals	138	8	9	7	0	162

Table 4.2 Summary of Artifact Types and Raw Materials Recovered from Early Prehistoric Components of Units 8N, 28W and 8N, 29W at EkPu-8 (Archaeological Survey, Provincial Museum of Alberta - unpublished data).

Artifact Type	silicified sedimentary	non-silicified sedimentary	quartzite	crypto-crystalline	other	Totals
Cores	0	0	0	0	0	0
Debitage	1093	6	7	38	11	1155
Tools	8	0	0	2	0	10
Totals	1101	6	7	40	11	1165

Table 4.3 Summary of Artifact Types and Raw Materials Recovered from Middle Prehistoric Components at Site 243R (Hudecek-Cuffe 1998).

Artifact Type	silicified sedimentary	non-silicified sedimentary	quartzite	crypto-crystalline	other	Totals
Cores	17	3	1	0	0	21
Debitage	2188	610	147	338	26	3309
Tools	3	0	0	0	0	3
Totals	2208	613	148	338	26	3333

Table 4.4 Summary of Artifact Types and Raw Materials Recovered from Early Prehistoric Components at Site 243R (Hudecek-Cuffe 1998).

Artifact Type	silicified sedimentary	non-silicified sedimentary	quartzite	crypto-crystalline	other	Totals
Cores	2	0	0	0	0	2
Debitage	89	3	0	6	1	99
Tools	0	0	1	1	0	2
Totals	91	3	1	7	1	103

Table 4.5 Summary of Artifact Types and Raw Materials Recovered from Early Middle Prehistoric Components at Site 1626R (Sandgathe 1997).

Artifact Type	silicified sedimentary	non-silicified sedimentary	quartzite	crypto-crystalline	other	Totals
Cores	1	0	0	0	0	1
Debitage	275	0	17	21	0	313
Tools	3	0	0	3	0	6
Totals	279	0	17	24	0	320

Table 4.6 Summary of Artifact Types and Raw Materials Recovered from Early Prehistoric Components at Site 1626R (Sandgathe 1997).

Artifact Type	silicified sedimentary	non-silicified sedimentary	quartzite	crypto-crystalline	other	Totals
Cores	0	0	0	0	0	0
Debitage	90	0	1	25	0	116
Tools	0	0	0	0	0	0
Totals	90	0	1	25	0	116

4.2.3 Size

As discussed above, it seems logical that, generally, larger flakes would be preferable over smaller flakes for application in most tasks. This is strongly reflected in the range of sizes of the flakes that had been categorized as utilized in the initial no-magnification analysis of the three archaeological assemblages. It was the size range of these initially identified utilized flakes that provided the general size criteria in selection of the samples. In combining the data from all three archaeological assemblages and both age periods, approximately 85% of the utilized flakes initially identified were ≥ 15 millimeters in greatest dimension. However, items ≥ 15 millimeters constituted less than 40% of the total assemblage. No utilized flakes were identified among the items ≤ 5 millimeters (as was noted by Bamforth [1985: 245] as well in Lubbock Lake sites) and only two of the utilized flakes identified were ≤ 10 millimeters in maximum dimension (< 0.2% of that size class) although items ≤ 10 millimeters comprise 31.9% of the combined assemblages (see Table 4.7). Of the initially identified utilized flakes 98.7% were greater than 10 millimeters in maximum dimension. A number of smaller flakes (< 10 mm) were, however, included in the samples in order to attempt to determine a potential cutoff point below which flakes may have been too small to be serviceable at all.

Table 4.7 Size distribution of siltstone and mudstone debitage from the Early Prehistoric components of all three archaeological assemblages.

Size Class	Frequency	Percent of assemblage	number initially identified as utilized	Percent of Size Class
≤5 mm	16	1.2	0	0.0
>5 ≤ 10	241	18.7	2	0.8
>10 ≤ 15	389	30.1	13	3.3
>15 ≤ 20	262	20.2	18	6.8
>20 ≤ 25	144	11.1	17	11.8
>25 ≤ 30	105	8.1	8	7.6
>30 ≤ 35	60	4.6	10	16.7
>35 ≤ 40	29	2.2	6	20.7
>40 ≤ 50	32	2.5	7	21.9
>50 ≤ 60	8	0.6	5	62.5
>60 ≤ 70	3	0.2	1	33.3
>70 ≤ 80	1	0.08	1	100.0
>80 ≤ 90	0	0.0	0	0.0
> 90	1	0.08	0	0.0
Total	1291	100 %	88	6.8%

Table 4.8 Size distribution of siltstone and mudstone debitage from the Middle Prehistoric components of all three archaeological assemblages.

Size Class	Frequency	Percent of assemblage	number initially identified as utilized	Percent of Size Class
≤5 mm	157	4.9	0	0.0
>5 ≤ 10	1026	31.9	0	0.0
>10 ≤ 15	934	29.0	8	0.9
>15 ≤ 20	538	16.7	12	2.2
>20 ≤ 25	241	7.5	14	5.8
>25 ≤ 30	121	3.8	6	5.0
>30 ≤ 35	91	2.8	9	10.0
>35 ≤ 40	57	1.8	6	10.5
>40 ≤ 50	34	1.1	5	14.7
>50 ≤ 60	11	0.3	3	27.3
>60 ≤ 70	4	0.1	0	0.0
>70 ≤ 80	2	0.06	0	0.0
>80 ≤ 90	1	0.06	0	0.0
> 90	0	0.0	0	0.0
Total	3217	100 %	63	2.0%

4.2.4 Edge Morphology

In selecting flakes based on edge morphology, more attention was given to flakes with relatively acute edges that would likely be better suited for most cutting than scraping tasks. The terms acute and obtuse are not used here in their strict sense. Relatively acute angles here are those with edge or spine plane angles of approximately 30 degrees or less. More obtuse angles are those greater than 30 degrees. This selection bias was justified based on the idea that flakes used for most cutting tasks would be less likely to acquire easily detected wear than those flakes use for most scraping tasks. This idea has been supported, for the most part, by the patterns exhibited by the experimental flakes produced for this thesis.

In each of the archaeological assemblages employed here there were typically several flakes which were large enough to warrant inclusion in the samples taken, but lacked any edges that would seem suitable for any conceivable tasks. This was not an issue of acuteness/obtuseness of edge or spine-plane angle. These flakes, due to irregularity of shape, presence of hinge terminations, *etc.* , typically lacked any sort of serviceable edge. It is certainly possible that flakes such as these could have served in tasks that have not been anticipated. However, if this were the case and the use-wear from such tasks is not easily recognized, it is difficult to know what sort of wear to look for and where to look for it on these items. Therefore, items that lacked any obviously serviceable edges were not included in the samples.

4.2.5 Site EkPu-8

The stratigraphy of this site was subdivided, on the basis of natural stratigraphic layering, into levels referred to as "Cultural Units" (Ronaghan 1993). This use of this term is continued here in regard to this site only (see Figure 3.7).

Of the three sites included in this thesis, Site EkPu-8 has produced the greatest quantities of lithic materials to date. The combined assemblages from Cultural Units 5 (Early Middle Prehistoric) and 6, 7, and 8 (Early Prehistoric) included 12,360 items of debitage, 12 cores and 158 tools). Of these items, 12,062 (96.3%) are of silicified and non-silicified clastic sedimentary raw materials. For practical purposes, a subset of the total site assemblage was selected for specific analysis. Two 1x1 metre units, out of 19 excavated (for which data were available), were selected as this subset. These two units were selected simply because their materials were among those still undergoing the cataloguing process and so were readily available (had not been stored yet). These two units represent approximately 10.5% of the area excavated for which data is available. The debitage from Cultural Units 5, 6, 7, and 8 of these two units (units 8N,28W and 8N,29W) comprised the sub-assemblage from which the sample of flakes for microscopic analysis were selected. This debitage sub-assemblage comprises approximately 11% of the total debitage from the same Cultural Units of the 19 1x1 metre excavated units.

The percentage of the total sub-assemblage represented by the samples is relatively low (see Table 4.9). However, the number of flakes either initially identified as utilized or included in the sample for microscopic examination comprise 6.3% of all flakes in the Middle Prehistoric sub-assemblage and 6.9% of all flakes in the Early Prehistoric sub-assemblage.

Table 4.9 Summary of debitage population and sample sizes from units 8N 28W and 8N 29W at Site EkPu-8.

Period	Site Components	Population of Flakes	Number of Sample Flakes	% of Total Population
Mid Prehistoric	5	54	7	13.0%
Early Prehistoric	6, 7, & 8	843	75	8.9%

4.2.6 Site 243R

Natural stratigraphic layering at Site 243R, while visible, is not as straightforward as that encountered at Site EkPu-8. Future work at this site will undoubtedly include a clarification of this natural layering and its relation to the cultural components. At present, however, defining discrete stratigraphic units has been necessarily arbitrary. The vertical locations of obvious concentrations of artifacts separated by layers with few if any artifacts were employed as crude guides to the placement of vertical boundaries. Seven stratigraphic units were established (see Chapter 3 and Figure 3.3).

Few temporally diagnostic artifacts were recovered from Site 243R and, while some radiocarbon dates have been acquired, several are still pending. Chronologic data for this site are currently limited. A tentative division was made, however, between components at this site into Middle and Early Prehistoric assemblages. This separation was based mainly on two radiocarbon dates and several projectile point types. The nature and locations of these, however, precluded any real confidence in the temporal divisions drawn. Several side-notched projectile points were recovered from Component 4. The age of these cannot be confidently placed any more specifically than Middle Prehistoric. One lanceolate projectile point was recovered from Component 7. While opinion varied among local researchers in the assignation of this point to a specific typologic category, there was no debate that, based on general morphology, it is of a Llano variety and is at least 10,000 years in age (Bryan 1997, Dawe 1997, Magne 1997). Two AMS radiocarbon dates have been acquired on very small charcoal samples recovered from a similar stratigraphic level as this projectile point. These dates were 8840±40 and 8410±40 radiocarbon years BP. This discrepancy between the radiocarbon dates and the typologic age of the lanceolate point was not unexpected. The origin of the charcoal was not clear but is likely "root burn" resulting from a vegetation fire associated with the A-horizon of a paleosol. The roots and lanceolate projectile point were located in the B-horizon of this paleosol which would be substantially younger (Hudecek-Cuffe 1998). Regardless, the age of this component is solidly placed in the Early Prehistoric (12,000 to 8000 years BP). The location of Component 5, between projectile points of Middle Prehistoric age (Component 4) and radiocarbon dates and a projectile point of Early Prehistoric age (Components 6 & 7), suggest for it a placement in either the Early Middle Prehistoric or the late Early Prehistoric. The assignment here to the former period is understood to be somewhat arbitrary at this time.

The total assemblage recovered from Site 243R during the 1996 and 1997 excavations by the University of Alberta Department of Anthropology's Archaeological Field School (Hudecek-Cuffe 1998)) numbers approximately 5400 items. Of these, approximately 5300 were lithic items (most of the remainder being fire-broken rock) and 5280 of these were debitage (including utilized flakes). The total debitage for Components 5, 6, and 7 is 3408 items. Of these 2890 (84.8%) are of clastic sedimentary raw materials (see Tables 4.4 and 4.5). These quantities were low enough so that no creation of a sub-assemblage was necessary.

The percentage of the total sub-assemblages represented by the samples is relatively low (see Table 4.10). However, the number of flakes either initially identified as utilized or included in the sample for microscopic examination comprise 9.3% of all flakes in the Middle Prehistoric and 16.3% of all flakes in the Early Prehistoric sub-assemblage.

Table 4.10 Summary of debitage population and sample sizes from Site 243R.

Period	Site Components	Population of Flakes	Number of Sample Flakes	% of Total Population
Mid Prehistoric	5	1697	59	3.5%
Early Prehistoric	6 & 7	50	3	6.0%

4.2.7 Site 1626R

Due to the close proximity of this site to Site EkPu-8, it is not surprising that the natural stratigraphy is of these two sites is very similar. Like Site EkPu-8, Site 1626R has quite distinct and uncomplicated natural layering which includes two obvious and identifiable volcanic tephras. These tephras along with ten radiocarbon dates (AMS and conventional) have provided good chronologic control for the site deposits. Thirteen natural layers, including the two tephras, have been identified above glacial till (see Chapter 3, Figure 3.5 for a more detailed description of site stratigraphy). The older tephra (Mazama ash - Bacon 1983) and several of the radiocarbon dates have allowed a fairly confident delineation between the Middle and Early Prehistoric deposits.

Analysis of the lithic artifacts recovered from this site in 1993 and 1994 was carried out by Darwent (1995). Analysis of the materials recovered in 1996 was carried out by this author (Hudecek-Cuffe 1998 - report in progress). Although Darwent's report included a comprehensive summary of the data collected from the lithic assemblage, the actual database compiled from the assemblage was not available. The database would be necessary to extract the information in a form compatible with the analysis carried out here. Therefore, only data from the lithic materials recovered in 1996 could be included here. The total debitage recovered from Site 1626R in 1996 was 854 items. Approximately 848 of these were debitage and of this debitage, 690 (81.4%) was of clastic sedimentary materials and 365 of these were recovered from the Early Middle Prehistoric and Early Prehistoric levels (see Table 4.11). It was, therefore, not necessary to create a sub-assemblage from which to draw the sample flakes for microscopic analysis.

Table 4.11 Summary of debitage population and sample sizes from Site 1626R.

Period	Site Components	Population of Flakes	Number of Sample Flakes	% of Total Population
Mid Prehistoric	8, 9, &11	220	33	15.0%
Early Prehistoric	12 &13	53	22	41.5%

4.2.8 Summary of Samples

While the samples from the Early Prehistoric debitage populations from two of the sites were below 10%, the total sample size from the total population (combined from the three sites) is 10.6 %.

Table 4.12 Summary of debitage population (all silicified sedimentary debitage, all debitage ≥ 10 mm, and debitage not identified as utilized in the initial site analysis) and sample sizes from Site 1626R.

Period	Total Number of Flakes in Population	Number of Sample Flakes	% of Population in Sample
Mid Prehistoric	1971	99	5.0%
Early Prehistoric	946	100	10.6%

Chapter 5 Lithic Raw Materials

5.1 Raw Material Types

The term "high quality" is often used in archaeology in reference to specific types of lithic raw materials. Quality in this context generally refers to the flakability of the material, typically based on the average knapping skill level among archaeologists. Obsidian is typically held to be the highest quality raw material because it is the easiest to manufacture recognizable, servicable tools from. Quartzite, on the other hand, is often considered a "low quality" material because it is much more difficult to work effectively. This definition of quality is not a necessarily a real thing and may not have been reflected in the attitudes of prehistoric people. However, materials such as obsidian were obviously highly sought after prehistorically judging from the level of their presence in the archaeological record. Still, casual transference onto prehistoric people of current value judgements based on present experience should be avoided. Many prehistoric knappers may have held other raw material qualities, besides ease of flakability, as most important.

Sedimentary Rocks

Sedimentary rocks can be divided into two different categories based on the nature of their formation. The first, exogenic rocks, are those sedimentary rocks that form from the accumulation of clasts or grains. These grains originate, for the most part, from the erosion of existing rocks and, through various forms of transport, are carried to their location of deposition. These grains are transported, deposited, and incorporated into sedimentary formations in the form of solid particles. The process of their origin as loose sediments and their reformation into a sedimentary rock is basically mechanical in nature. Sandstones are perhaps the best example of this form of sedimentary rock which makes up the vast majority of all sedimentary rocks (Pettijohn 1975: Chapter 2). The second category includes those rocks which form through chemical processes or endogenic rocks. This involves mainly the precipitation from solution of dissolved materials. The resulting formations can have amorphous internal structure, as with limestones, or they can form through the growth of crystalline structures, as with rock salt. Cherts can occur in various slightly different forms but, by definition, they all fall into this second category (Pettijohn 1975: chapter 2).

Cherts

Even among geologists there is a lack of consensus in defining chert and other related materials and terms such as flint, jasper, and chalcedony. However, unlike the situation in archaeology, geologic definitions of materials typically depend as much or more on formation processes as on constituent materials or physical appearance. Different cherts may have *slight* differences in their formation processes and/or internal structures but they are all classified as precipitates and generally form from dissolved silica. They are chemical sedimentary as opposed to clastic sedimentary rocks. The silica may originate from other silica-bearing formations or from small crustacean shells dissolved in water. The silica itself occurs in several different forms. Three common forms are quartz, chalcedony, and opal. Quartz is silica with a crystalline structure, opal is silica with an amorphous internal structure, and chalcedony is silica with a microscopic fibrous structure. Within the relatively homogeneous matrix of cherts, clasts may occur in the form of either unrelated impurities in particle form or as undissolved portions of crustacean shells (Luedtke 1992; Pettijohn 1975: Chapter 11).

The liberality with which archaeologists use geologic terms, as demonstrated by the application of the term chert to other materials in the Alberta Eastern Slopes, is, apparently, not uncommon (Luedtke 1992: Chapter 2). This is understandable as archaeologists are typically less interested in the conditions of origin or chemical composition of lithic materials (typically the defining criteria of cherts) as they are with simply knowing from where the material from which an artifact was manufactured was acquired prehistorically. However, the improper application and common usage, within archaeology, of originally geologic terminology is in part due to a general lack of knowledge about the proper geologic definitions of those terms. For example, the term chert tends to be applied by archaeologists to a wide variety of lithic raw materials with little discrimination. It is the case that within geology itself there is a degree of disagreement about the actual definition of chert, but these discussions revolve mainly around an understanding of the specific conditions that lead to the formation of chert and its variety of forms rather than what the chemical and mineralogical makeup of the material is (Luedtke 1992: chapter 3 and Pettijohn 1975: chapter 11). There are certain established, accepted criteria that do exclude certain types of silica bearing rock from the classification chert. While cherts are considered polygenic they are also categorized as nonclastic or chemical sediments (Pettijohn 1975: 392). Chert is defined by Pettijohn as:

> - . . . the most common chemical siliceous sediments.
> -Chert is a dense rock composed of one or several forms of silica - opal, chalcedony or microcrystalline quartz.
> -Other minerals present, usually those found in adjacent sedimentary rocks, must be considered impurities. (Pettijohn 1975: 394)

One of the several potential origins of chert is that it can form from sediments that were originally clastic in nature. Specifically, some geologists suggest that the very fine grains of materials such as slate or mudstone can be replaced or augmented by silica to such an extent that the resulting material can no longer be considered clastic and has taken on the properties of a chert (Pettijohn 1975: 394-401). These would be the conditions under which a bedded chert forms and explains the often close and clinal association of silicified clastic sediments (which may have a high silica content but are still dominated by the original clastic materials) with cherts (the original clastic material has become secondary to the silica content), as is the case with the Banff/Norquay Chert Formations (Fedje et al. 1995).

As mentioned briefly above, the geologic distinction between cherts and other, perhaps similar, materials is not typically of interest to the archaeologist. This occurs because the interest among archaeologists has been more to do with the relative amenability to flaking of materials rather than more specific physical characteristics. Prehistoric exploitation of these different materials may well have included an interest in and an understanding of physical properties beyond ease of manufacture. For example, properties that influence tool durability (i.e., hardness or brittleness) may have been considered more important in certain circumstances. This may have been the case specifically in the Eastern Slopes of Alberta where lithic raw materials which are known by archaeologists for their ease of flakability are, and presumably were, relatively scarce.

Siliceous Clastic Sedimentary Rocks

Once a sedimentary rock has formed it can, and often does, undergo further processes that can result in radical changes to the appearance and nature of that rock. This is referred to as diagenesis (Pettijohn 1975: 275). Diagenetic processes can include the application of heat and pressure or can be the loss or addition of materials to the original formation. In the case of porous materials water will often percolate through a formation carrying dissolved silica from one location and depositing it within the spaces between the original particles in another. This silica will then act as a cement, filling in spaces and consolidating the original particles into a stronger, harder, denser material. This specific process is not confined to clastic rocks and can occur in carbonate rocks such as limestone and dolomite as well. The result is again a harder, denser material. This same consolidation process can occur in which iron, rather than silica, is the cementing material. However, iron cemented rocks are not as strong as silica cemented ones and silica is by far the most common cementing material on the earth (Pettijohn 1975: 239).

This is the general origin process of the silicified siltstones, silicified mudstones and silicified carbonate rocks that occur in archaeological sites in the Alberta Rocky Mountains. As the Alberta Rockies are comprised primarily of sedimentary rock formations it is not surprising that silicified forms of these would be quite common here (Gadd 1995).

5.2 Lithic Raw Materials in the Alberta Rocky Mountains

Few sources of what most archaeologists would describe as high quality raw materials, in the context of flaked stone tool production, have been identified in the Alberta Rocky Mountains. Several types of chert are commonly known and referred to. Two of the better known types are Etherington Chert (Loveseth 1976) and Banff/Norquay Chert (Fedje et al. 1995). Neither of these is, overall, a particularly good quality material (although occasional small samples occur that are relatively high quality as far as flakablity is concerned) and they do not tend to occur in large quantities or large pieces.

Etherington Chert

The main source of Etherington Chert is on the north side of Crowsnest Pass within the Livingston Range in southwest Alberta. It is a bedded chert and appears to have been affected by post-formational contact-metamorphosis that produced intensive internal crazing. Prehistoric extraction of the chert may have also included the heating and cooling of the exposed outcrops in order to facilitate breaking them apart. This practice would have undoubtedly contributed to internal fracturing as well. This material is variegated (probably also a result, in part, due to heating) with colours ranging from light grey to orange and red (Loveseth 1976).

Banff/Norquay Cherts

Banff/Norquay cherts are available at various limited locations in the Bow Corridor adjacent to the Banff townsite. These cherts are often expressed as two different formations but may in fact originate from the same specific formation. They are also bedded cherts and occur in association with silicified siltstones and silicified mudstones with a grading of characteristics between these. This has resulted in the term Banff Chert being commonly applied to artifacts and debitage which would be more accurately described as silicified clastic rocks. These cherts tend to occur in dark colours, either black or dark grey or brown. They also tend to develop a white or light grey patina on the outer, exposed surface of a piece due to a chemical reaction with the air (Fedje et al. 1995).

Silicified Sedimentary Materials

While several specific quarry sources of these materials have been noted by researchers working in Alberta (Brink personal communication 1997; Vivian personal communication 1997; Loveseth 1976; Anderson and Reeves 1975), these materials appear to be available throughout the Eastern Slopes. Acquiring them prehistorically would probably have been a simple matter regardless of where in the Eastern Slopes of Alberta a human group was situated. Specific sources of these materials that might have been used more extensively than others in prehistory may come to light. However, the current data suggest that these materials were so naturally ubiquitous that it seems unlikely that any specific localized sources would significantly influence prehistoric lifeway patterns in the region as a whole. That is to say that a prehistoric group would not likely have to take any one specific raw material source into consideration when organizing their movement and settlement patterns because raw material availability appears to be fairly homogeneous throughout the Eastern Slopes. The nature of these materials (as they occur in archaeological contexts) appear to vary considerably throughout this region. This variation includes gradations in the size of the original clasts, the silica content, and, less significantly, in the color. The different varieties appear to be readily available throughout the whole region. However, further archaeological field work and general familiarity with this region on the part of archaeologists is necessary to confirm these impressions.

Clast Size

The terms sand, silt, and clay have come, by convention within geology, to refer to specific ranges in the lower end of the overall size range of detrital particles or clasts. While variations in the specific placement of the boundaries between the different size categories have been put forward, the generally accepted size ranges for these three terms is as follows:

SAND = particles with a diameter between 2 mm and .05 mm or 1/16 of a mm.
SILT = particles with a diameter between .05 mm or 1/16 of a mm and .005 mm or 1/256 of a mm.
CLAY = particles with a diameter less than .005 mm or 1/256 mm.
(Pettijohn 1975: Chapter 2)

Silica Content

Determining the percentage of silica present in a clastic material is more complicated than it would initially seem. This is because a distinction is necessary between the silica content of the original clastic material and the added silica cement (Pettijohn 1975: 239). At present there is no quick and easy method for determining the actual silica content of a rock. Thin section slides of a material can give practical indications of silica levels but their preparation is very time consuming and would be excessively expensive on the scale necessary to provide a reasonable data base of available material types for the Eastern Slopes region (Wayman 1997: personal communication). While determining actual silica content is, at present, difficult, the simple feel and appearance of a sample allows the determination of rough categorizations such as "poorly cemented" or "high silica content". These broad categorizations allow discussions, at least, about raw material choices among prehistoric groups.

5.3 Exotic Lithic Materials

Exotic materials are those that do not occur locally and if they occur at a site they serve as evidence of access, whether direct or not, to specific distant sources by the people who created the site. The value of the information that can be provided by the identification of exotic materials at a site is obvious. The identification of exotic materials from specific sources can potentially allow the reconstruction of group movements and relations with adjacent groups of people. Changes in the types and sources of exotic materials at a site or in region allow insight into changes in specific behaviour over time.

Lithic raw materials that have been identified as exotic in Middle and Early Prehistoric components of archaeological sites in the Eastern Slope are rare. Materials that are unquestionably exotic are even more rare. Some examples do exist, however. The raw materials recovered from the three sites included in the thesis provide an idea of the typical frequency of occurrence of potentially exotic and obviously exotic lithics.

At site 243R in Jasper National Park, no materials were recovered that were undoubtedly exotic. Potentially exotic materials included chalcedony from a single concentration and several isolated items of a "high quality" chert. Specific sources of both these materials are not known and so they may have been acquired from some distance. It is possible, however, that they do occur relatively near by naturally, but in limited quantities (Hudecek-Cuffe 1998 - report in progress).

At site EkPu-8 in the James Pass several examples of potentially exotic materials were recovered. Two types of "high quality" chert were recovered and identified as Knife River Flint from the North Dakota and Top of the World Chert from south eastern British Columbia. These materials were identified mainly by colour and, while much experience was brought to bear by the specific analyst in this case, it is still possible that cherts of similar appearance do occur in limited quantities locally. One material recovered in very limited quantities from EkPu-8 that was undeniably exotic was obsidian (Dawe and Ronaghan 1997 and Ronaghan 1993). No sources of obsidian have been discovered to date anywhere in the Alberta Rocky Mountains and the scarcity of this material in archaeological sites here would tend to suggest that there are no local sources for it.

Obsidian was also recovered in limited quantities from Site 1626R which is located very near to EkPu-8. This was the only exotic or potentially exotic material recovered from this site (Darwent 1995). X-ray fluorescence analysis of samples of this obsidian matched it most closely to a source in eastern Idaho called Bear Gulch (Bailey 1997).

Chapter 6 Experimentation

6.1 Use-Wear Experimentation Background

Early on in the history of lithic use-wear experimentation a debate developed over the best form which these experiments should take (Vaughn 1985; Keeley 1980; Hayden and Kamminga 1979; Schiffer 1979). One side of the argument maintains that in order to most accurately reproduce wear patterns that would presumably have occurred prehistorically, experiments should be designed so that they closely mimic the actual tasks that prehistoric people would have carried out. Rather than breaking up actual tasks, such as butchering an animal, into discrete aspects of that task, such as cutting meat or cutting hide or severing ligaments, an experimental tool or tools should be employed for the whole of the task. The experimental tool(s) should be employed from start to finish so that it will acquire all the wear that would have occurred in the carrying out of a comparable task prehistorically. In other words the unit of measurement of use-wear should be the general task as a whole rather than a quantification of the different aspects of that task. The logic is that if the intention is to identify the cause of wear patterns on prehistoric tools by comparison to experimentally produced wear patterns then the experimental wear patterns should be the result of actual tasks and realistic behaviour that would have been practiced by prehistoric people (Frison 1989; Keeley and Newcomer 1977, Odell 1980).

The other school of thought is that the intention of this type of research should be to arrive at an in-depth understanding of all the variables involved in the formation of wear patterns. This requires the collection of very specific empirical data. The measurement of use-wear must then be based on an empirical quantification of the specifics of variables such as: duration of use, mechanics of use, tool raw material, tool edge form and task material. This type of data can then be applied to various different tasks, conditions and situations rather than being narrowly task specific. The argument here is that experiments designed simply to replicate specific tasks produce wear that has limited pertinence as an example of behaviour and fails to anticipate or account for all the possible wear patterns that could result from multiple task applications of a single tool (Vaughn 1985; Hayden and Kamminga 1979; Schiffer 1979).

This latter line of reasoning is given more attention here. The former school of thought makes the mistake of attempting to pre-determine the actual form prehistoric behavior would have taken and then looks for evidence of that specific behaviour in the material remains. I believe that the more rational approach is to identify, as accurately as possible, all the variables that could have factored into the formation of the material record, then attempt to ascertain what exact interaction of these variables would be necessary to bring about the conditions observed in the prehistoric material record. As an example, the butchering of a deer from start to finish includes several different task materials (hair, hide, flesh, sinew, and possibly bone). If we can only recognize the specific edge-damage produced by application to the sum of these task materials and we do not know what type of edge damage is produced by each of these task materials then we will be unable to recognize tools that have only been applied to portions of this task or similar ones. It is this point of view which is, in part, the underlying conceptual framework for the experiments developed for this thesis.

6.2 Thesis Experimentation

6.2.1 Problems and Approach

This thesis does not directly address issues of replication of specific use-wear patterns. While the careful recording of the wear patterns created by the different tasks undertaken is an important part of these experiments, the main issue in the use-wear aspect of this thesis addresses the level of importance of tool raw material as a variable in the formation and recognition of tool edge damage. The main question deals with the potential for the unique physical properties of specific raw materials to resist the formation of readily observable use-wear, especially in situations in which the tools in question may have undergone limited use before they were discarded for fresh ones. Therefore, the experiments here were not designed explicitly to create and quantify the nature of edge-wear resulting from specific tasks as much as to determine if wear actually occurs under certain conditions and, further, if use-wear does form, does it occur to levels that allow detection by archaeologists using practical methods.

6.2.2 Experimental Tools

Large cobbles of dark grey to black silicified siltstone/mudstone were collected from an outcrop in Banff National Park (Permit No. WRA97-01). The cobbles were of a silica cemented clastic sedimentary material with grains in the silt/mud size range and with a high silica content that fell well within the range observable in archaeological assemblages throughout the Eastern Slopes. The rock was determined to be a clastic, rather than chemical, sedimentary material based on two criteria. The first was that, although individual grains were not visible to the naked eye, under low-powered magnification the clastic nature of the material could be discerned. The second criterion was that an application of HCl (hydrochloric acid) to the surface of the material, even high concentrations, did not produce a reaction. A reaction would be expected with any chemically derived rocks that are not predominantly silica based (such as limestone or dolostone). Chemically derived rocks such as limestone and dolostone were avoided as raw materials in the experiment because, even though they are readily available throughout the Alberta Rockies (Gadd 1995), they constitute only a minor component of the assemblages from the sites included in this study (Dawe and Ronaghan 1997; Francis 1997; Hudecek-Cuffe 1998 - report in progress) and in most sites excavated in this region to date (e.g., Fedje et al. 1995; Fedje 1988, 1986; Van Dyke 1987; Pickard 1984; Reeves 1976). Limestones and dolostones can and do undergo a similar form of diagenesis as clastic rocks with the addition of silica cements which would, assumedly, result in their being more suitable to the production of stone tools. However, the use of HCl solution for the cleaning of the debitage assemblages from all three sample sites in this study demonstrated that calcareous rocks such as limestone and dolostone were very rare among the raw materials.

Occasionally, possible indications of heat-treating are noted in site assemblages in the Eastern Slopes (Hudecek-Cuffe 1997, 1998 - report in progress; Francis 1997; Darwent 1995) and, while there is no definitive indication that these local silicified sedimentary materials were modified in this manner, casual experiments in the heat-treating of these materials (Gryba n.d.) has produced results that would suggest, at least tentatively, that this practice may have improved their workability if it had been applied. Some debitage from Site 243R exhibited ranges and patterns of colour within individual items that could indicate intense heating. However, distinguishing heat-treated from untreated examples of these materials is difficult as there is, apparently, little in the way of colour change. Therefore, determining whether this practice had occurred here prehistorically is problematic. However, because there is a possibility that the heat-treating of these lithic raw materials was practiced in the Eastern Slopes, it was considered important that among the experimental tools here were included tools that were produced from heat-treated materials. A large cobble of black silicified siltstone was heated to a temperature of approximately 600° F for about four or five hours (Gryba n.d.). While this did make the material slightly more lustrous, any obvious changes in physical properties were not evident during the reduction process.

Both the untreated and treated cobbles were reduced, in a random manner, resulting in several hundred flakes with several dozen of these being of a size that was suitable for use as a hand held tool. The majority of the flakes were too small to be comfortably used as a tool. A small quartzite cobble weighing 220 grams was used to reduce the cores. As each flake was struck-off it was caught in the hand before it could hit the floor so as to avoid incidental fracturing. Each flake was also examined for any spontaneous retouch (Newcomer 1976). One flake was removed from the experimental assemblage because of some quite dramatic spontaneous retouch (Plate 3) that I would have unquestioningly classified as intentional retouch had it been noted in an archaeological assemblage (see Plate #3 and Chapter 2, Previous Research, under the section "Spontaneous Retouch During Production" for a further discussion of this).

The resulting assemblage of suitable sized flakes was then examined for any edge damage and those flakes that lacked a usable length of cutting/scraping edge were discarded. The remaining flakes that were intended for experimental use were each placed individually in a plastic bag and stored securely in a box to prevent any direct contact with other flakes and to prevent any movement that could potentially produce other incidental edge damage or wear.

6.2.3 Applications

In order to address the concerns of both schools of thought on use-wear experimentation, the experiments here were set up in two parts. Part A was designed to mimic an entire actual task and involved the dressing out and quartering of an adult female mule deer (*Odocoileus hemionus*). Part B of the experiments involved a more controlled approach and the separation of more specific butchering tasks and included the application of flake tools to tasks and materials not associated with butchering.

6.2.3.1 Part A

The first part of the experiment, the dressing out of a deer carcass, was performed with minimal methodological control. The rationale for this approach was that this part of the experimentation should be kept as casual as possible (within certain parameters) in order to allow a level of individual choice and decision making that might be expected in the behaviour of individuals going about this process as part of their actual lifeway.

This process began by making an incision up the ventral line from sternum to loin exposing the abdominal cavity. Incisions were then made around the anus and urinary tract, releasing these aspects from their connective tissue and releasing the caudal end of the intestines. The pubic bones were then cut apart with a hacksaw (this tool was used for this task based on the reasoning that this would not, and could not have been done with a small expedient flake in a practical manner and prehistorically these bones would likely have been smashed apart with a large stone). The head was then separated from the atlas vertebra by selectively cutting the surrounding muscle and the specific ligaments connecting the two. This was done by feeling beneath the overlying tissue for recognizable landmarks on the atlas and occipital region of the skull which allowed the direct insertion of the flake edge between to cut the connective tissues. Removal of the head allowed the severing of the esophagus and trachea, releasing the cranial end of the intestines and allowing the easy removal of all the offal from the abdominal cavity. The front limbs were then severed at the joint between the carpals and the radio-ulna. The hind limbs were severed at the joint between the tarsals and the metatarsals. The remaining carcass (excluding the head and the severed distal limb portions) was then skinned completely. The carcass was then quartered with the front and hind limbs being severed from the pectoral and pelvic girdles respectively.

The whole process was carried out by two researchers, one using only untreated flakes while the other used only flakes of the heat-treated material. Flakes with more acute edge angles (≤ 30 degrees) tended to be selected for this part of the experiment. As cutting was the only anticipated form of use-mechanics for the dressing out of the deer, flakes with more acute edge angles were seen as likely more effective and the obvious logical choice. A conscious effort was made to ensure that both researchers carried out relatively equal portions of the task and applied their respective tools to all specific aspects of the task. These specific aspects included cutting through hair, hide, ligaments, tendons, meat, and included minimal contact with bone surface. Each experimenter went through several flakes in the course of this part of the experiment. As soon as there was a noticeable reduction in the performance of a flake it was replaced with a new flake and notes were made about the specifics of its use. There did not have to be a significant change in the performance of a flake, just a detectable one, before it was replaced. While this was inherently subjective and none of the discarded flakes had actually lost much of their serviceability, any diminishment in performance was not difficult to detect.

A small arrow was applied in indelible ink back from the flake edge to indicate precisely which portion of each tool's edge was used and a dot was applied to that surface of the flake which was to the thumb side of the grip during use. Upon completion of Part A, record sheets were filled out for each flake used. This provided each flake with a catalog number and included notes about the specifics of its application and its orientation in the researcher's hand.

6.2.3.2 Part B

This part of the experiment involved a more rigorous empirical approach. Tools were applied to discrete tasks and their use was quantified. The duration of each use-episode was pre-set and maintained, regardless of any change in performance (the one exception to this was cutting raffia - see below). Each use-episode was carried out in a methodical way that included counting the number of strokes made in the allotted time, measuring the length of the strokes, recording the angle of the tool edge, and recording the angle at which the tool edge was applied to the task material surface. Prehistoric use of hand-held expedient flakes are assumed here to include mainly two general types of motor mechanics. These would be strokes that run parallel to the use-edge of the tool (cutting/sawing/slicing) and strokes that run perpendicular to the use-edge of the tool (scraping).

Task Materials

In general, the type and nature of tasks included in the experiments were selected to cover a range of task materials. As the concern of this thesis is with the potential for flakes that had been utilized to go unrecognized by archaeologists, it was important to include a number of tasks that are less likely to produce wear quickly and noticeably: that is, tasks which involve the working of softer materials. Certain tasks, such as scraping antler and wood, would be expected to produce rapid and obvious wear. It was judged that flakes used for these tasks would be unlikely to go unnoticed in an archaeological assemblage regardless of the tool raw material and the level of examination. However, scraping antler and wood were included as a check on these expectations.

The specific task materials included in the experiment were selected in order to provide a wide range of material types ranging from relatively hard (antler, wood) to relatively soft (fresh meat, carrot). Generally included in the experiment were tasks, or reasonable facsimiles of tasks, that were very likely to have been carried out prehistorically in the Eastern Slopes based on the judgement of this researcher. These were tasks such as cutting fresh meat, cutting fresh hide, scraping fresh hide, cutting dry hide (leather), carving (cutting) dry antler, carving (cutting) wood, cutting fibers such as grass for baskets/fabrics, and cutting fresh plants such as tubers during food collection and/or preparation.

Table 6.1. Tasks and task materials included in Part B of the experimentation.

		Soft Materials			Medium Materials		Hard Materials	
Task Mechanics	Duration-minutes	Carrot	Meat	Fresh Hide	Dry Hide	Raffia	Wood	Antler
Cutting	1	X	X	X	X	X	X	X
	5	X	X	X	X	X	X	X
	8					X		
	10	X	X	X	X			
Scraping	1			X			X	X
	5			X			X	X
	10			X			X	

Each of these 27 tasks was carried out twice: once with a heat treated flake and once with a non-heat treated flake.

It was not considered necessary to the thesis to try to reproduce all possible tasks that might have been carried out in this region in the past. As previously mentioned the main intention of the thesis is to attempt to determine if, and possibly how much, use-wear is going unrecognized in assemblages from this region. Therefore, only a relatively small representative sample of tasks and tasks types was included.

Many other tasks and task materials could have been included in these experiments but were left out because their inclusion would add little more to the weight of the thesis than is provided by those tasks included. Of specific note, vegetable materials are not as well represented among the experimental task materials as they probably were among prehistoric task materials. Stone tools may have been used to collect herbaceous plants for food or medicinal use. These vegetable materials would likely represent a wide range of levels of hardness, but would tend to be of medium hardness somewhere between the softer materials like meat and the hard materials like wood and antler. Drier vegetable materials, such as dry grass which could conceivably be used to produce fabrics for various uses, would likely be slightly harder and likely to cause more significant edge wear on stone tools than materials like fresh herbaceous plants but are still softer than wood. The three vegetable materials included or represented in the experiments, wood, grass and tuber/root, are representative of the range of hardness that might be expected within the wider category of vegetable materials available in the Eastern Slopes. The wood included in the experiment was a dried branch of the saskatoon shrub (*Amelanchier alnifolia*) approximately 1.5 centimeters in diameter. Raffia (dried leaf fibers from the Madagascar palm *Raffia ruffia*) was used here in the place of grass because of its general similarity to dried grass and because it is more easily acquired in useful lengths and quantities than local grass (in the city centre of Calgary in winter). Raffia is available at most craft stores. The tuber/root of the species camas (*Camassia quamash*) was a plant commonly used for food by prehistoric groups both in the Plateau region west of the Eastern Slopes and in Northern Plains to the east (Brisland 1992). Edible species of camas do currently occur in the Eastern Slopes and may well have been included in prehistoric diets here (Gadd 1995). Other tuber/roots may also have been collected and processed as food or medicine. Carrots (*Daucus carota*) were included in the experiment as a facsimile to these types of resources.

Methods

For each discrete tool application and task material three use-episodes were carried out, each increasing in duration. Thus, for scraping fresh hide, for example, a one minute, a five minute, and a ten minute episode were carried out respectively, each with a fresh flake. With this approach it was reasoned that, if detectable wear occurred through the specific use of a tool edge, the rate at which the wear accumulated could be roughly monitored. That is to say, at what point and/or at what rate does wear appear and accumulate. It was also reasoned that if a specific task did not produce detectable wear on flake-tools of this material, ten minutes of use should be long

the performance of the flake tools in Part A of the experiments.

While the rate of discard in Part A was different for each researcher, neither one used any one flake for more than ten minutes before it was judged to be diminished in performance and replaced. If detectable wear did not occur after ten minutes of use then it seemed unlikely that it would occur at reasonably detectable levels at all. Based upon the understanding that one of the major inherent advantages of expedient technology is that as soon as a flake no longer functions optimally it can be casually discarded and replaced by another with little or no regard for economy of raw material, these experimental applications involved minimal duration and number of actions. The continued experimental use of an expedient tool and continued damage to its edge long after it no longer functions optimally, or even well, seems pointless (e.g., Keller 1966). Experiments of this nature would produce wear patterns that we could expect not to occur in tools in prehistoric assemblages.

In the case of scraping antler the maximum duration was limited to five minutes. This was based on the fact that easily detectable wear had occurred on the tools used for this task well before the five minute mark and so including a ten minute session would not have provided any more useful data.

In the part of the experimentation involving the cutting of raffia the intention had initially been to include ten minute sessions (one for a heat treated and one for a non-heat treat flake). However, after six or seven minutes of use, performance of the tools had diminished so much that they were no longer cutting the material but were crudely fraying it. Therefore, the maximum duration for cutting raffia was reduced to eight minutes.

Motor Mechanics

Part B included 54 individual task experiments, Equally divided between heat-treated and untreated tools. Nineteen of the 27 tasks involved cutting oriented motor mechanics. **Cutting** is defined here as back and forth strokes of the hand and tool (typically away from and toward the front of the individual's body) that are parallel in direction relative to the cutting edge of the tool. The assumed intention of cutting is to separate connected materials by inserting a solid plane between them. In cutting strokes there is a tendency to apply the pressure on the pulled stroke (toward the body) and not on the pushed stroke (while this may not be an absolute in some situations it was the case in all respective applications here). This may be seen in contrast to **sawing** motor mechanics in which the application of pressure may not differ between the push and pull strokes or may be greater in the push stroke. Another related type of mechanical application was noted during the experiments involving the carrots. In the application of flake tools to the carrots some of the task involved cutting, as it is defined above. However, the separating of the carrots into smaller portions was often achieved by simply pushing the sharp edge of the flake directly into the material rather than pulling the edge across the surface to cut the material. This direct insertion of the tool into the material, perpendicular to the material surface, is termed **slicing** here.

Eight of the 27 tasks involved scraping oriented motor mechanics. **Scraping** is defined here as back and forth strokes of the hand and tool (also typically away from and toward the front of the individual's body) with, in this case, the working edge of the tool perpendicular to this motion and with the pressure applied exclusively to the pull stroke. The assumed intention of scraping is to detach connected tissues by physically pulling one portion from the other with a strong shearing action. (see Tringham et al. 1974, for an earlier discussion of mechanical actions).

6.2.4 Recording Observations

For the recording of observations made without the aid of magnification in this study, a simple system was used that allowed the expression of the degree of visibility (or lack there of) of wear or potential wear. The observational choices were;

No discernible wear	NDW
No obvious wear	NOW
Possible discernible wear	PDW
Some discernible wear	SDW
Easily Discernible wear	EDW

These categories were developed for application here to illustrate the range of visibility, without aid of magnification, of edge-damage. They are not set out here for use in the analysis of an archaeological assemblage. The categories of degree of edge-damage for use in archaeological analysis are listed in the section Recording Observations Made With the Microscope under the heading Degree of Wear.

No discernible wear would indicate that there was no modification to any margins of the flake that could be seen with the naked-eye. **No obvious wear** would indicate that there might be some limited modifications to one or more margins but that no patterning can be observed with the naked eye that would lead the observer to suspect it as anything other than incidental edge damage (e.g., trampling in the case of the archaeological samples). **Possible discernible wear** would indicate that there are limited modifications to one or more margins which could be use-wear, but without the aid of microscopy this cannot be determined satisfactorily. **Some discernible wear** means that some limited wear-patterning is visible upon close scrutiny but it is not obvious and could possibly escape detection, especially during the analysis of several hundreds or thousands of flakes. **Easily discernible wear** indicates that there is obvious wear present and that it would not easily go undetected.

It must be stressed that these descriptions of level of wear are based on the fact that it was known that these flakes had been utilized and that there was no modification to their edges prior to this use. There was no question that any modification to the flakes had to be due to that application. In the case of flakes of unknown histories, the discriptors, as they are defined above, would not be applicable. It would be impossible to escape the bias that the knowledge of the history of the experimental flakes brings to the analysis. Questions of other potential factors that come into play when looking at archaeological assemblages for indications of utilization (e.g., edge damage that could occur during the reduction process or post-reduction trampling) obviously are not an issue when analyzing experimental assemblages. The researcher cannot pretend to take into account factors that obviously have no bearing. Any attempt to try to recreate, synthetically, the mental conditions that govern judgement in the analysis of archaeological assemblages in the analysis of experimental ones should be highly suspect. Therefore, no attempt was made here to do that. In assigning the flakes from the archaeological samples to categories it was impossible to avoid taking into account other potential factors such as those mentioned above.

For the majority of the experimental flakes the damage that resulted from their use was so minute and unpatterned to the unaided eye that similar damage observed on flakes of unknown history could not confidently be considered use-wear. In my judgement only that level of damage that was classified as easily discernible wear (EDW) would be confidently recognized as use-wear in an archaeological assemblage. The category, some discernible wear (SDW), was included to encompass edge damage that was visible but of ambiguous origin that may possibly be identified as use-wear by some analysts but not by others. The remaining three categories, possible discernible wear (PDW), no obvious wear (NOW), and no discernible wear (NDW), included flakes that, if their history were not known, would not be identified as utilized without the aid of some magnification.

Observations with Magnification

Since a practical methodology for the detection of use-wear was one of the major aims of this thesis, expensive and often inaccessible high-powered microscopy (both higher power incident light microscopy and scanning electron microscopy) was ruled out immediately (Odell 1982: 20). The practical approach would necessarily have to revolve around some sort of low-powered microscopy. The simple geologist's hand-lens, typically with 10X magnification, was the obvious first choice. These items are very inexpensive and easily acquired. However, in attempting the use of the hand-lens for this purpose I found it to be very awkward. As one hand of the researcher is required to hold the lens itself, this leaves only one hand to manipulate the object being viewed. Furthermore, these lens have to be held right up to the object being viewed making it impossible to view the whole object through the lens. This makes it very difficult to orient both the object itself and, in the case of flakes, to determine accurately the location of specific landmarks, such as edge-damage, on the flake as a whole. With a hand-lens it was very difficult to carry on rapid, accurate and methodical observations.

The next logical choice was a typical low-powered (<50X) stereoscopic microscope. Various relatively inexpensive, but suitable, versions of these are readily available in most if not all archaeology/anthropology/geography departments. The one used here was a 20X stereoscopic incident light microscope mounted on a swinging arm stand, borrowed from the Department of Anthropology at the University of Alberta in Edmonton. This particular set-up was especially useful for examining flakes because the microscope itself is mounted on a long horizontal bar which moves it, and the business of manipulating the flakes under examination, away from the microscope stand. The area beneath the microscope is less confined than with the typical stereoscopic microscope.

Recording Observations Made with the Microscope

For recording observations made with the aid of magnification categories were defined that allowed a control on the major aspects of patterning of wear on a utilized flake edge. The three general aspects are location of wear, nature of wear, and degree of wear. In order for the accurate recording of these aspects, however, they are broken down into five categories with their various possible choices:

Wear Surface - upon what side(s) of the edge is the wear located
- Bifacial (BF) - wear on both adjacent surfaces of the edge
- Unifacial (UF) - wear on only one of the two adjacent surfaces of the edge
- Neither (NT) - wear is on the very tip of the edge and is of a nature that it does not extend specifically onto either surface enough to consider it bifacial or unifacial (e.g., roughening, crushing, rounding)

Surface - specifically, on which side of the flake is the wear located
- Dorsal (DO)
- Ventral (VE)
- Both (BO) - bifacial wear
- Neither (NT) - see definition above

Margin Wear is Located On * (Figures 6.1 and 6.2)
- Right Margin (RT)
- Left Margin (LF)
- Distal Margin (DM) - opposite platform end
- Proximal Margin (PM) - platform end

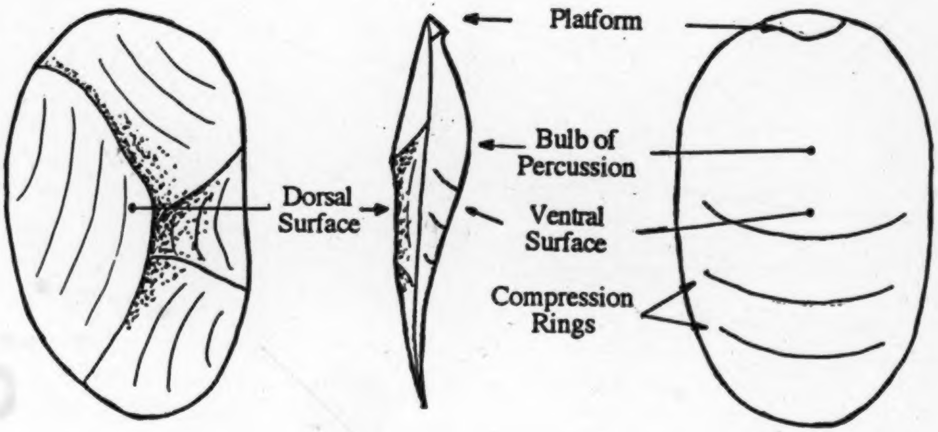


Figure 6.1 Diagram illustrating features of flake morphology that distinguish the dorsal and ventral surfaces. Terminology (e.g., proximal, distal, left, right) is based on a view of the ventral surface of a flake with the platform end up.

---

* These terms are based on a view of the ventral side of the flake with the platform end oriented up (Figure 6.1).

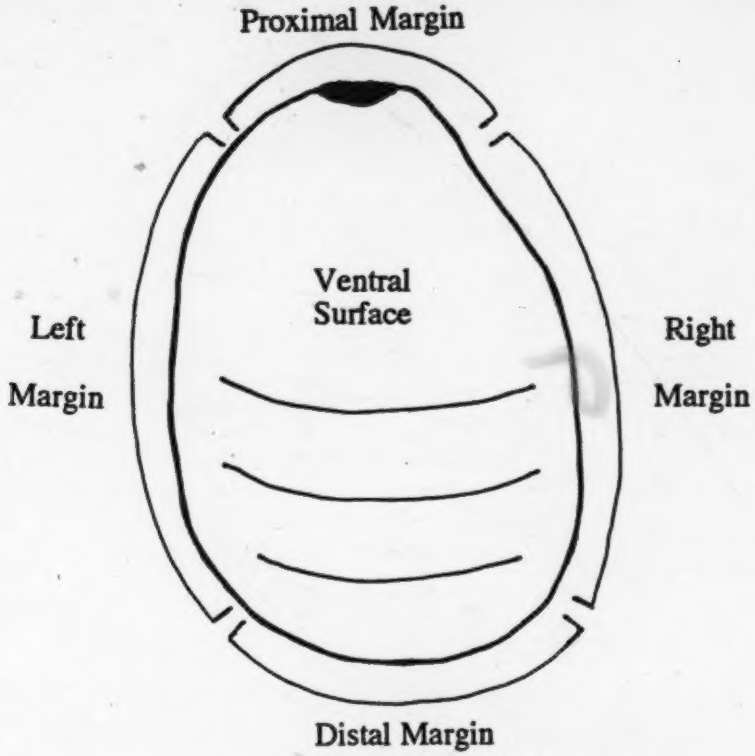


Figure 6.2 Diagram illustrating general flake margins.

Location on Margin** (Figure 6.3)

Proximal (PR) - end of indicated margin closest to platform

Central (CN) - in center of indicated margin

Distal (DI) - end of indicated margin opposite to platform

Entire (EN) - this means that the distribution of wear is over the entire edge (not restricted to one segment of the edge) but does not mean the entire edge has wear.

** These choices of location are defined here as they were applied only to the archaeological assemblages and the experimental flakes used for scraping tasks. In the analysis of the experimental flakes that were used for cutting tasks the terms **proximal** and **distal** were not used. Instead, the terms **leading** and **trailing** were used. The leading edge is the end of the utilized margin that made initial contact with the task material upon each stroke, while the opposite or trailing edge was the end of the margin to be in contact last. This terminology was used because, in the case of the experimental flakes, the orientation of the utilized edge to the task material was known and the description of this use could be more explicit.

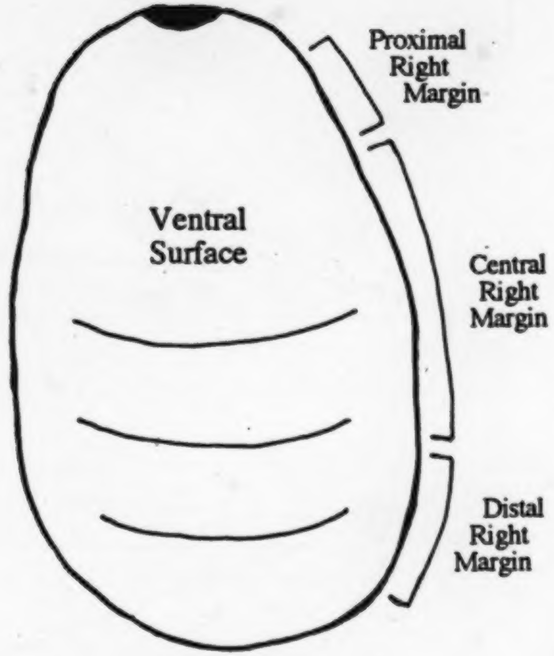


Figure 6.3 Diagram illustrating division of general margin into specific areas.

Type of Wear - the form that the damage to the flake edge has taken.

Microscarring (MS) - very small flake scars - ca. < 2 mm "deep" (i.e. distance from margin edge to point of termination of flake)

Microchipping (MC) - typically refers to tiny (< 2 mm deep) step fracturing, especially on relatively obtuse edge angles

Snap Fracture (SF) - fractures that result from a portion of an edge being laterally snapped off like the breaking of a stick. This results in a scar, the surface of which is more or less perpendicular to the flake edge. However, this surface is often oriented slightly off perpendicular which can allow the determination of the direction of the pressure that produced the break.

Attrition (AT) - movement of the flake edge in toward the centre of the flake due to extensive wear and continuous loss of microflakes and microchips (see Plate 4).

Crushing (CR) - unpatterned modification of an edge due to the removal of large chunks and grains rather than flakes or chips.

Roughening (RO) - minute crushing (loss of < 2 mm of edge) and removal of edge material in grain (rather than flake) form that compromises the original shape of the very tip of the edge in a contiguous but poorly patterned manner.

Striations (ST) - typically microscopic linear scratches in the flake surface.

Polish (PO) - microscopic decrease in the surface relief compared to rest of flake surface (due to the wearing-off of individual grains of material) that increases the lustre of the material surface.

Rounding (RD) - More extensive shearing-off of surface material at the tip of the flake edge that results in a change in the cross-section of the edge from a sharp angle to a smooth blunt curve.

Nature of Wear - the general distribution of wear (Figure 6.4)

Irregular (IR) - location of individual scars, chips, fractures, etc., is unpatterned

Regular (RE) - location of individual scars, chips, fractures, etc., is patterned although they are not necessarily adjacent to each other.

Contiguous (CO) - the scars, chips, fractures, etc. are all adjacent to each other with few, if any, undamaged spaces between.

Small or Short Section (SS) - wear occurs in contiguous section that is less than 10 millimeters in length.

Intermittent (IN) - multiple, separate sections of (usually minor) regular wear.

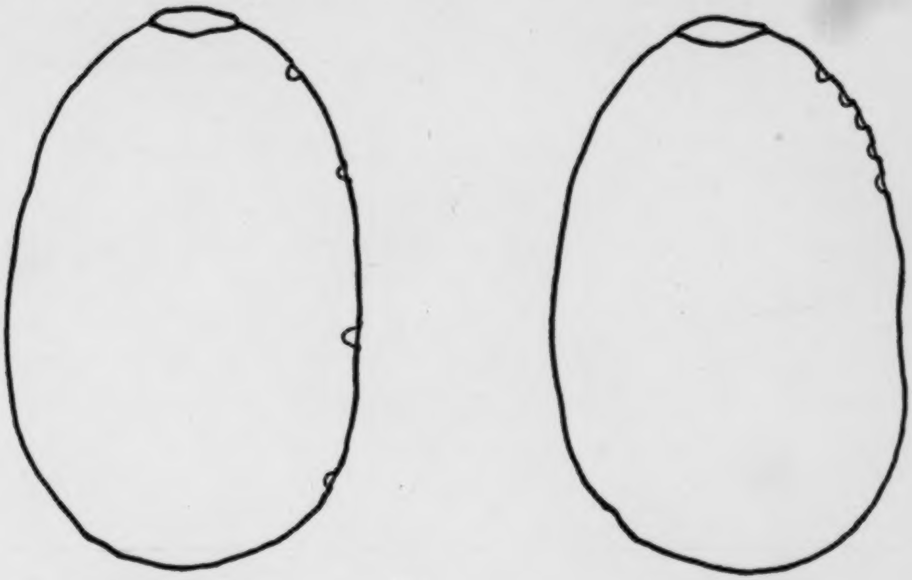
Degree of Wear - extent of wear (In the case of roughening, crushing, rounding, or polishing quantification is difficult, but all were rare occurrences in the experimental and archaeological samples).

Negligible (NG) - in the case of microscarring or chipping less than 2 to 6 randomly spaced scars. Attrition would never be catagorized as negligible.

Minor (MI) - extent and patterning of edge-damage is observable but limited. Six to 12 evenly spaced or contiguous scars.

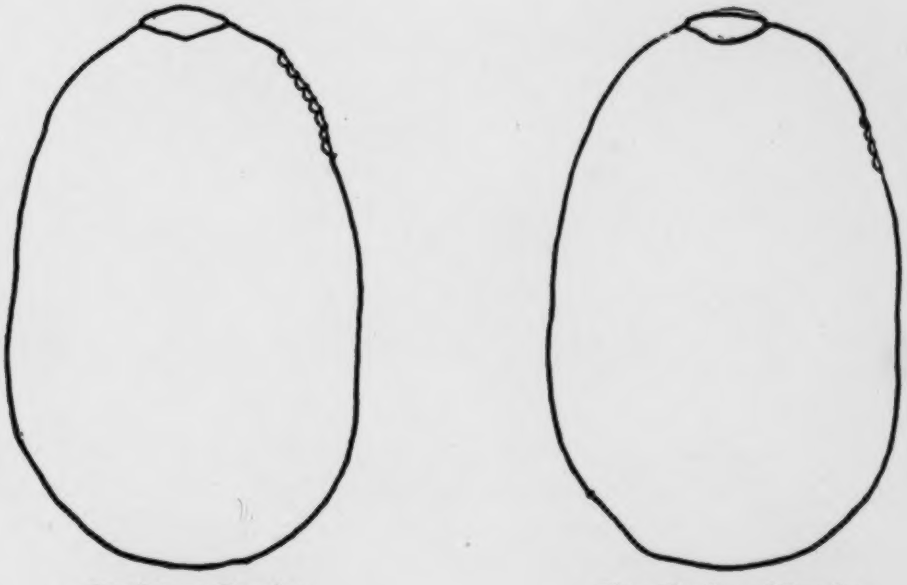
Substantial (SU) - wear has reached a point at which the nature of its patterning is easily observable under the microscope. More than 12 scars.

Extensive (EX) Numerous scars - edge-damage has reached a point where it might be visible without the aid of magnification but still could easily go unrecognized due to the small size of the edge-damage.



Irregular Scarring

Regular Scarring



Contiguous Scarring

Short Section of Scarring

Figure 6.4 Illustration providing examples of nature of wear.

6.3 Results of Experimentation

6.3.1 Part A

6.3.1.1 Task Description

Nine flakes were employed in this part of the experiment and the entire process lasted approximately 30 minutes; cutting was the only action involved.

Because the decision as to when a tool's efficiency had diminished enough to warrant its replacement was left up to the individual researcher's judgement, there was a difference in the number of flakes each researcher used in this first part of the experiments. In spite of the fact that the portions of the task as a whole, carried out by each researcher, were roughly equal, one researcher used six heat-treated flakes and the other used three flakes that were untreated. At the time of the experiments there was no obvious indication that there was any correlation between the number of flakes each researcher used and whether the flakes were heat-treated or not. Based upon discussions following the experiment, the discrepancy in the number of flakes used was tentatively attributed to individual preference rather than actual differences in performance between the two sets of tools.

Contrary to the expectations of both researchers, little contact between the tool cutting edges and bone occurred or was necessary. The separating of two connected bones was more easily accomplished with the stone tools than had been anticipated. The actual joints were not overly obscured by surrounding tissue and the severing of the ligaments was carried out with a relative accuracy that did not require much unnecessary contact with bone surface. Thus, it became apparent that the butchering of a large animal could be accomplished with little application of tool edges to any material harder than a fresh hide.

The one major impediment to performance of a flake during butchering was the build-up of hair and tissue along the tool edge. This build-up would occasionally reach a point at which the tool was no longer serviceable and the researcher would have to stop momentarily and carefully clear the edge of the tool before continuing. Hair, more so than tissue, tended to cause this hindrance. While this was not a major problem, it was noted that this would more readily affect a flake with an edge that was not perfectly even. Any flake edge with irregular notches or protrusions along the edge being used would tend to clog up more rapidly and required cleaning more often.

It should be noted that, although diminished performance could be detected in any one flake tool after a certain length of use, and this resulted in multiple flakes being used to complete Part A, the decrease in performance was minimal and both researchers expressed the opinion that, if necessary, one or perhaps two flakes would have sufficed for the dressing out of the entire deer.

It was anticipated that, at the level of examination intended for this thesis, no real difference in edge-damage was expected between the flakes applied in this part of the experimentation (which included cutting meat and fresh hide) and those applied in Part B to cutting meat and fresh hide.

6.3.1.2 Unaided Examination

Of the nine flakes used in Part A, none acquired wear that was substantial enough to be recognizable as such without the aid of magnification. One flake was classified as having no discernible wear, four had no obvious wear, and two had possibly discernible wear. The two flakes that exhibited the most wear were described as having some discernible wear. As mentioned above this description takes into account the fact that it was known that any damage to this flake was necessarily caused by the experimental application. While the edge damage was visible it required close scrutiny to detect and was minute enough that on a flake of unknown history, without the aid of magnification to detect patterning, it could not be confidently considered use-wear, if it had even been noticed in the first place.

6.3.1.3 Examination With Magnification (20X)

All nine flakes did acquire some use-wear that occurred as either microscars or minute snap-fractures; however, the wear was very limited. Two of the flakes acquired wear categorized as negligible and the other seven acquired wear categorized as minor.

Four flakes had some bifacial microscarring, which consisted of a small number of microscars (< 8 in total) irregularly spaced along the cutting edge. One of these four had a short section of more regular bifacial microscarring at the trailing end of the cutting edge.

Six flakes had some unifacial wear. Two of these six had irregular unifacial wear: one with wear distributed along the whole of the edge and the other with an irregular short section at the trailing end of the edge. Four of the six had patterned or regular unifacial wear. One of the four had a short section in the centre of the edge while the other three had a short section at the trailing end of the edge. Of the six flakes with unifacial wear five had the wear on the side of the flake that had been facing the thumb of the researcher during application. Of these, four had the section of wear at the trailing end of the cutting edge. In fact, in six of the nine flakes, all the damage, or at least the most significant, was at the trailing end of the cutting edge (figures 6.5 and 6.6).

The fact that damage is focused more on the trailing end of the cutting edge than on the rest of the edge is not surprising in flakes with relatively straight cutting edges. Typically, during the act of cutting, the tool is held so that the edge being applied is at somewhat of an angle to the surface of the task material. The leading end of the edge is raised and the trailing end is lowered (Figure 6.5). This is because the direction of the motion of the cut is more across, or parallel to the surface of the material, rather than down into the material in a direction directly perpendicular to the material surface. The length of the cutting edge must be oriented obliquely, to a certain degree, to the direction of the cut. The edge being applied at an oblique angle to the material surface and cutting direction provides the optimum cutting efficiency. This results in the leading end of the edge coming into far less contact with the task material than the trailing end (figure 6.6). Also, depending on the size of the flake, the length of the intended cutting edge, and the specific way in which it is being grasped, the leading end of the cutting edge may be somewhat protected from more rigorous contact with the task material by the user's fingers. The trailing end of the edge thus tends to acquire the most wear. While this tends to be the case with flakes with relatively straight cutting edges it may not hold true for flakes with cutting edges that have a significant convex curve. In these cases the curvature of the cutting edge provides the necessary obliqueness of angle between edge and task material and the edge does not necessarily need to be manually oriented to provide this condition. In this case it is possible that leading and central, rather than trailing, portions of the edge might receive the most wear. This did not seem to be the case with those flakes used in Part A. Two had some degree of convex curvature and both had the most significant wear at the trailing end of their cutting edges. The curvature of these two flakes, however, was not substantial.

As was discussed above, striations were not expected and were not a form of edge-damage that was detected among any of the flakes used in Part A.

6.3.1.4 Summary of Part A of the Experimentation

While some edge-damage was incurred by all nine flakes in Part A, none acquired wear to a degree that would have been confidently recognizable in an archaeological assemblage. Microscopic examination would be necessary to observe these levels of wear. Even with microscopic examination, an analyst might have some difficulty with the level of confidence possible in describing the two flakes with negligible levels of edge-damage as being utilized if the flakes were from an archaeological assemblage.

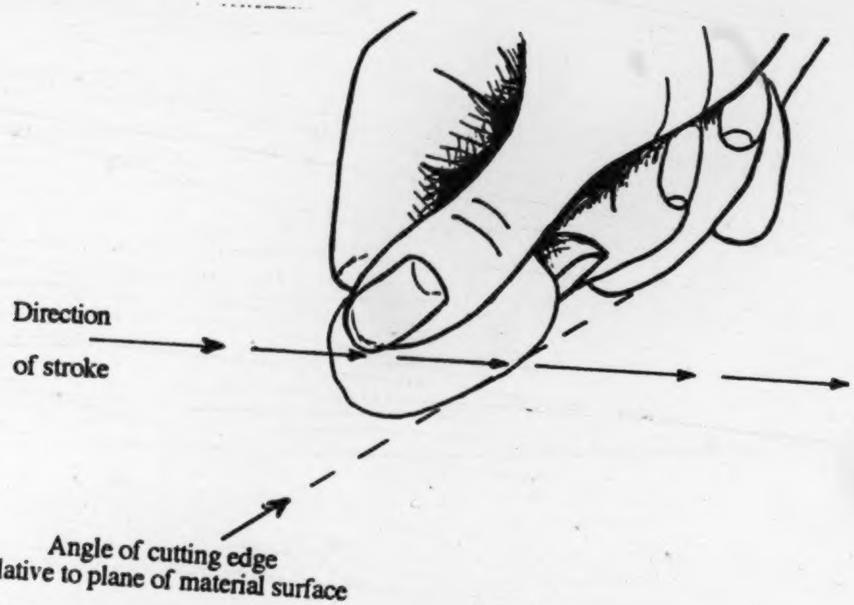


Figure 6.5 Illustration of manual orientation of flake with length of cutting edge held obliquely to the surface of the task material for effectiveness of cutting.

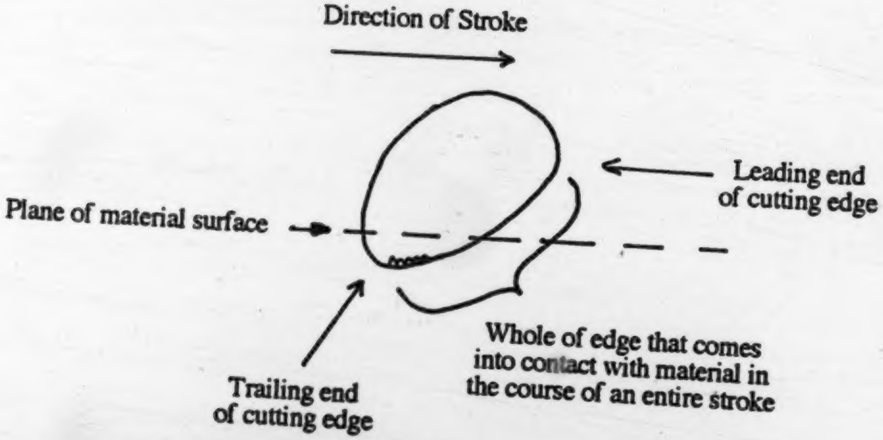


Figure 6.6 Illustration of oblique orientation of the length of cutting edge to the task material which results in the trailing end of the cutting edge being in contact with the material far more than the leading edge.

6.3.2 Part B

6.3.2.1 Task Description

Fifty-four flakes were used in this part of the experimentation: 38 were applied to cutting tasks and 16 to scraping tasks (see Table 6.1).

6.3.2.2 Unaided Examination

Easily Discernible Wear (EDW)

Of the 54 flakes only six (11%) acquired what was categorized as easily discernible wear (EDW). Four of these six were used for scraping tasks and the other two for cutting tasks. All six were applied to hard materials; one for scraping wood, three for scraping antler, and two for cutting antler.

Of the ten flakes applied to wood for either cutting or scraping only one acquired EDW. This was tool #TB-12 which was the heat treated flake used to scrape wood for ten minutes.

Eight flakes were applied to antler (four scraping and four cutting). Five of these acquired EDW. These five included all four non-heat treated flakes that had been applied to antler and one heat treated flake. The one heat treated flake (TB-16) was used to scrape antler for five minutes, the maximum duration for this specific task (see Plate 4).

Some Discernible Wear (SDW)

Three of the 54 flakes (6%) acquired some discernible wear (SDW). As with those with EDW, these three were ones applied to hard materials. One was heat treated and used to scrape antler for one minute, one was non-heat treated and used to scrape wood for one minute and the third was non-heat treated and used to scrape wood for five minutes.

Possible Discernible Wear (PDW)

Eleven of the 54 flakes (20%) acquired possible discernible wear (PDW). Two of these were applied to antler and six were applied to wood. Three of the ten were applied to soft materials. Two of these three (scraping hide and cutting meat) were used for the maximum length of time for that task (ten minutes each). The third one (TB-23) was used for cutting raffia for five minutes. This is slightly incongruous as the two flakes used to cut raffia for the maximum (eight minutes) had less wear (NOW and NDW). Close inspection of tool TB-23 revealed that it had been removed from a portion of the core that was slightly less silicified than the rest of the core. The resulting tool edge was, therefore, more amenable to damage than was typical for the majority of the flakes.

No Obvious Wear (NOW)

Seven flakes (13%) acquired no obvious wear (NOW). One, UB-13, was applied to a hard material (cutting wood for one minute). Of the remaining six, one was used to cut dry hide for five minutes, one for cutting fresh hide for one minute, one for cutting meat for one minute, one for scraping fresh hide for one minute, one for cutting raffia for five minutes, and one for cutting raffia for eight minutes.

No Discernible Wear (NDW)

The largest category, with 27 of the 54 or 50%, were those flakes showing no discernible wear (NDW). All of these were flakes applied to soft materials: 23 in cutting tasks and four in scraping tasks.

Table 6.2 Degree of visibility of edge-damage on experimental flakes from Part B.

degree of wear	Heat-treated			Non heat-treated			Total # in wear class	% of total
	cutting	scraping	Total	cutting	scraping	Total		
NDW	12	1	13	11	3	14	27	50
NOW	1	1	2	5	0	5	7	13
PDW	6	3	9	1	1	2	11	19
SDW	0	1	1	0	2	2	3	6
EDW	0	2	2	2	2	4	6	11
Total	19	8	27	19	8	27	54	100

NDW = no discernible wear, NOW = no obvious wear, PDW = possible discernible wear, SDW = some discernible wear, and EDW = easily discernible wear

The higher numbers of untreated flakes with Some Discernible and Easily Discernible Wear might be due to differences in durability and wear patterns, but it would require a larger sample to determine this with greater confidence (see Table 6.2). As it is, there is no apparent significant difference in the degree of visible edge-damage between the heat-treated and non-treated flakes. While there are more untreated than treated flakes with SDW and EDW (six for untreated and three for treated), these numbers are both low and, in fact, there are also more untreated than treated flakes with No Discernible and No Obvious Wear (19 for untreated and 15 for treated). The area of greatest difference is in the numbers of flakes with Possible Discernible Wear (two for untreated and nine for treated), but this would seem not to be particularly informative with regard to heat-treating as a factor in edge-damage.

Table 6.3 summarizes a patterning of edge-damage that was anticipated. The nine flakes that incurred the most edge-damage (SDW and EDW) were applied to hard materials and only one of the flakes applied to hard materials incurred NOW or NDW. Of the 11 flakes with PDW, eight had been used on hard materials.

Table 6.3 Degree of visibility of edge-damage in relation to level of hardness of task materials

Task material hardness	NDW	NOW	PDW	SDW	EDW	Total
Soft	19	3	2	-	-	24
Medium	8	3	1	-	-	12
Hard	-	1	8	3	6	18
Total	27	7	11	3	6	54

Soft materials include meat, fresh hide, and carrots. Medium materials include dry hide and raffia. Hard materials include wood and antler.
NDW = no discernible wear, NOW = no obvious wear, PDW = possible discernible wear, SDW = some discernible wear, and EDW = easily discernible wear.

6.3.2.3 Summary of Unaided Examination

Of the 54 flakes employed in Part B of the experimentation, only nine acquired either Some Discernible or Easily Discernible Wear. Of these nine, six were used for scraping hard materials and 2 were used for cutting hard materials. The six flakes that acquired Easily Discernible Wear are the only ones (11.1%) of the 54 that would undoubtedly be classified as utilized by this analyst if they had been observed in an archaeological assemblage. The three with Some Discernible Wear might be suspected as utilized but would be highly questionable. None of the other flakes included in the experiments would be likely to be identified as utilized. This means that even if the three with SDW were included with the six flakes with EDW as likely being identifiable as utilized in an archaeological assemblage, more than 80% (83.3%) would have gone un-recognized.

6.3.2.4 Microscopic Examination

Two of the descriptors, No Discernible Wear (NDW) and No Obvious Wear (NOW), used in the unaided examination of the experimental (and archaeological samples) were also used in the description of the edge-damage observed with magnification. It should be kept in mind that the definitions and implications of degree of edge-damage of these common descriptors is not necessarily the same in both levels of examination. However, since both of these specific descriptors involve a lack or scarcity of observable edge-damage, no matter what level of examination is involved, no further interpretations are made from these.

Tables 6.4, 6.5, and 6.6 provide general summaries of the occurrences of the different categories of edge-damage as observed under the microscope. If the categories Substantial and Extensive and possibly Minor Wear represent those levels of use-wear that could be recognizable with the aid of low-powered microscopic examination, then the results here suggest that approximately 50 to 60 % (31 out of 54 = 57.4%) of utilized flakes would be identifiable.

Table 6.4 Summary of degree of edge-damage observed with microscopic aid on flakes used in cutting and scraping tasks in Part B.

Task Type	N NDW/NOW	N negligible wear	N minor wear	N substantial wear	N extensive wear	Total Number
cutting	17	3	12	5	1	38
scraping	2	1	4	3	6	16
Total	19	4	16	8	7	54

Extensive Wear

It must be stressed that this is a term that is defined in relation to the other categories of lesser wear and should be viewed only as a relative descriptor.

Seven (13.0%) of the 54 flakes acquired what was categorized as extensive wear. Only one of these was applied to a cutting task and this involved cutting antler. The other six flakes with extensive wear were applied to scraping tasks. Three were used for scraping wood and three for scraping antler. Out of the 38 flakes applied to cutting only one (2.6%) acquired extensive wear. Of the 16 flakes applied to scraping, six (37.5%) acquired extensive wear.

Substantial Wear

Eight (14.8%) of the 54 flakes acquired substantial wear. Five of these were used for cutting tasks and three were used for scraping tasks. Of the five used for cutting tasks two were applied to antler, one to wood and two to dry hide. Of the three used for scraping one was applied to antler and two to wood. Of the 38 flakes used for cutting, five (13.2%) acquired substantial wear and of the 16 flakes used for scraping, three (18.8%) acquired substantial wear.

Minor Wear

Sixteen (29.6%) of the 54 flakes acquired minor wear. Twelve of these were applied to cutting tasks and four to scraping tasks. Of the twelve used for cutting one was applied to antler, three to wood, three to raffia, two to dry hide, one to fresh hide and two to meat. Of the four used for scraping one was applied to wood and three to fresh hide. Of the 38 flakes used for cutting, 12 (31.6%) acquired substantial wear and of the 16 flakes used for scraping, four (25.0%) acquired substantial wear.

Negligible Wear

Four (7.4%) of the 54 flakes acquired negligible wear. Of these four, three were applied to cutting tasks and one to scraping tasks. All three used for cutting were applied to meat and the one used for scraping was applied to fresh hide. Of the 38 flakes used for cutting, three (7.9%) acquired negligible wear and of the 16 flakes used for scraping, one (6.3%) acquired negligible wear.

No Discernible Wear

Nineteen (35.2%) of the 54 flakes did not acquire any discernible wear. Seventeen of these were applied to cutting tasks and two were applied to scraping tasks. Of these 17 cutting tasks one applied to meat, five to fresh hide, two to dry hide, three to raffia, and six to carrot. The two scraping tasks were both applied to fresh hide. Of the 38 flakes used for cutting, 17 (44.7%) acquired no discernible wear and of the 16 flakes used for scraping, two (12.5%) acquired no discernible wear.

Table 6.5 Summary of edge-damage (as observed with aid of a microscope) by material treatment and task mechanics for all flakes from Part B.

degree of wear	Heat-treated			Non heat-treated			Total # in wear class	% of total
	cutting	scraping	Total	cutting	scraping	Total		
NDW	9	1	10	8	1	9	19	35.2
Negligible	1	0	1	2	1	3	4	7.4
Minor	5	3	8	7	1	8	16	29.6
Substantial	4	1	5	1	2	3	8	14.8
Extensive	0	3	3	1	3	4	7	13.0
Total	19	8	27	19	8	27	54	100

NDW = no discernible wear

Table 6.6 Summary of edge-damage, as observed under the microscope, compared to level of hardness of materials to which the flakes in Part B were applied.

Task material hardness	NDW	negligible wear	minor wear	substantial wear	extensive wear	Total
Soft	14	4	6	-	-	24
Medium	5	-	5	2	-	12
Hard	-	-	5	6	7	18
Total	19	4	16	8	7	54

Soft materials include meat, fresh hide, and carrots. Medium materials include dry hide and raffia. Hard materials include wood and antler. NDW = no discernible wear.

Table 6.7 indicates the relationship between the levels of observable edge-damage without magnification and the levels of edge-damage observable on the same flakes with the aid of 20X magnification. It is not surprising that among those NDW flakes observed without magnification to have No Discernible Wear the majority also had NDW under microscopic examination. Likewise, those flakes initially categorized as having Some Discernible Wear or Easily Discernible Wear all exhibited either substantial or extensive edge-damage under the microscope. However, flakes having either minor and/or substantial edge-damage (as observed under the microscope) occurred among flakes of all the no-magnification categories including those flakes that were categorized as having No Discernible and No Obvious Wear. While initial categorization without magnification was generally related to categorization with magnification this relationship was not absolute. Some flakes had edge-damage that could easily be recognized as use-wear under low-power magnification but which could not be detected with the unaided eye.

Table 6.7 Frequency of flakes in categories of edge-damage observed without magnification, frequency of flakes in categories of edge-damage observed with magnification, and the percentage of the former represented by the latter.

description of flake margins without use of magnification	Frequency (column 2)	description of same flakes with use of magnification	Frequency (column 4)	% of frequency in col. 2 represented by column 4
No Discernible Wear	27	No Discernible Wear	18	66.7
		Negligible Wear	3	11.1
		Minor Wear	4	14.8
		Substantial Wear	2	7.4
No Obvious Wear	7	No Obvious Wear	1	14.3
		Negligible Wear	1	14.3
		Minor Wear	5	71.4
Possible Discernible Wear	11	Minor Wear	7	63.6
		Substantial Wear	4	36.4
Some Discernible Wear	3	Extensive Wear	3	100.0
Easily Discernible Wear	6	Substantial Wear	2	33.3
		Extensive Wear	4	66.7

Taking into account that it is known that all these flakes have been utilized, I believe that only those flakes categorized as having either substantial or extensive wear would be confidently identified, under low-power magnification, as having actual use-wear. With increased individual experience an analyst would likely be able to include among these, those flakes with levels of edge-damage that here are categorized as minor. This would be an important step as among the utilized flakes included here 16 (29.6%) were categorized as having minor edge-damage.

6.3.3 Summary of Experimentation Results

For the nine flakes used in Part A to butcher the deer, microscarring was the predominant form of edge-damage. Much of the microscarring occurred as individual scars irregularly spaced along the use-edge. Seven of the nine flakes however, did acquire some patterned microscarring. This tended to be in the form of a short unifacial section of three to seven adjacent microscars of approximately equal dimensions. After viewing a number of these unifacial sections on different flakes it became apparent that this was a common form for the use-wear to take on tools used for cutting. This contradicts commonly asserted associations between bifacial wear and cutting, on the one hand, and unifacial wear and scraping on the other (e.g., Brisland 1992: 62; Kooyman 1985; Vaughn 1985: 111-113; 373-375; Odell and Vereecken 1980: 98; Tringham et al. 1974: 188). While unifacially patterned microscarring did not always occur with cutting tasks, it was common enough to bring the above assertions into serious question. The results here indicate that, contrary to common suggestion, distribution of damage on one or both sides of the tool edge is not always an indication of the mode of use (i.e., cutting vs. scraping).

A potential cause of unifacial wear in cutting tasks is suggested here to be the unintentional orientation of the tool edge to the line of direction of the cutting. If the tool edge, in the course of each stroke, is held absolutely parallel to the direction of the stroke then, all else aside, the tendency for wear to occur on one side of the tool edge or the other should be equal. If the cross-section of the cutting edge is not symmetrical (isometric) then there may be a tendency for the microflakes to detach off one side more than the other. If this were the main cause behind the occurrence of the unifacial wear observed on flakes used for cutting here then the damage should occur most frequently on either the dorsal or ventral surfaces of the flakes. This is reasoned because lack of symmetry in edge cross-section tends to be related to the differences in the orientation of the respective planes of the dorsal and ventral surfaces. This was not the case here. There is no apparent relationship between the occurrence of unifacial wear and any potential asymmetry associated with dorsal-ventral relationships. The relative occurrence of damage on dorsal and ventral surfaces was roughly equal (19 ventral and 17 dorsal).

There seems to be a greater relationship between the side of the flake that was facing the thumb at time of use and the side which incurred the most damage. Of the 22 flakes used in cutting tasks that acquired unifacial wear, 16 (73%) had the wear on the thumb side of the flake while six (27%) of the 22 had the unifacial wear on the side opposite the thumb. This suggests a tendency, on the part of the researchers here (and likely most others) to hold the flake during use in such a manner that the plane of the flake and the cutting edge are not absolutely parallel to the direction of the cut resulting in more pressure occurring on one side than the other (Figure 6.7). Any microscarring will tend to occur on the "lee" side of the flake as it passes through or over the surface of the task material. Further experimentation is needed to more firmly establish this. In particular, experiments should be done in which edge damage on flakes used by left- and right-handed researchers be compared (both researchers here were right-handed). Flake 5232A from Site 1626R is an example of this pattern of edge-damage observed among the archaeological samples (see Plates 5 and 6). The pattern of damage on this flake would be consistent with that observed on most of the experimental flakes used for cutting in which the microscarring was unifacial and occurred at the trailing end of the use-edge. The pattern of damage on this flake would be consistent with use by a right-handed individual if the above interpretation is correct.

Similar edge-damage patterns were observed on tools used for cutting in Part B as were seen in Part A. While the level of hardness of the task material certainly was a factor in the development of edge-damage, it was more a factor in the degree of wear rather than in the nature of wear. For most cutting tasks the majority of the damage was in the form of sections of adjacent unifacial microscars. In some cases these are

sections). In cutting particularly hard materials, such as antler, the edge-damage may include some microchipping. Microchipping was, however, most commonly associated with scraping tasks and most particularly in scraping hard materials. In tasks involving extended periods of scraping hard materials the microchipping began to occur at rates that resulted in a certain degree of attrition of the use-edge. These were the flakes most readily identifiable as utilized (see Plate 4 for an example of microchipping and attrition).

Only one of the flakes included in the Part B experiments exhibited what appeared, under magnification, to be striations. This was the heat-treated flake used to scrape wood for ten minutes. If the observation of striations is held to be the necessary criteria (Brose 1975: 88; Tringham et al. 1974: 175 after Semenov 1964) for identifying utilized flakes then all but this one flake would have gone undetected in an archaeological assemblage.

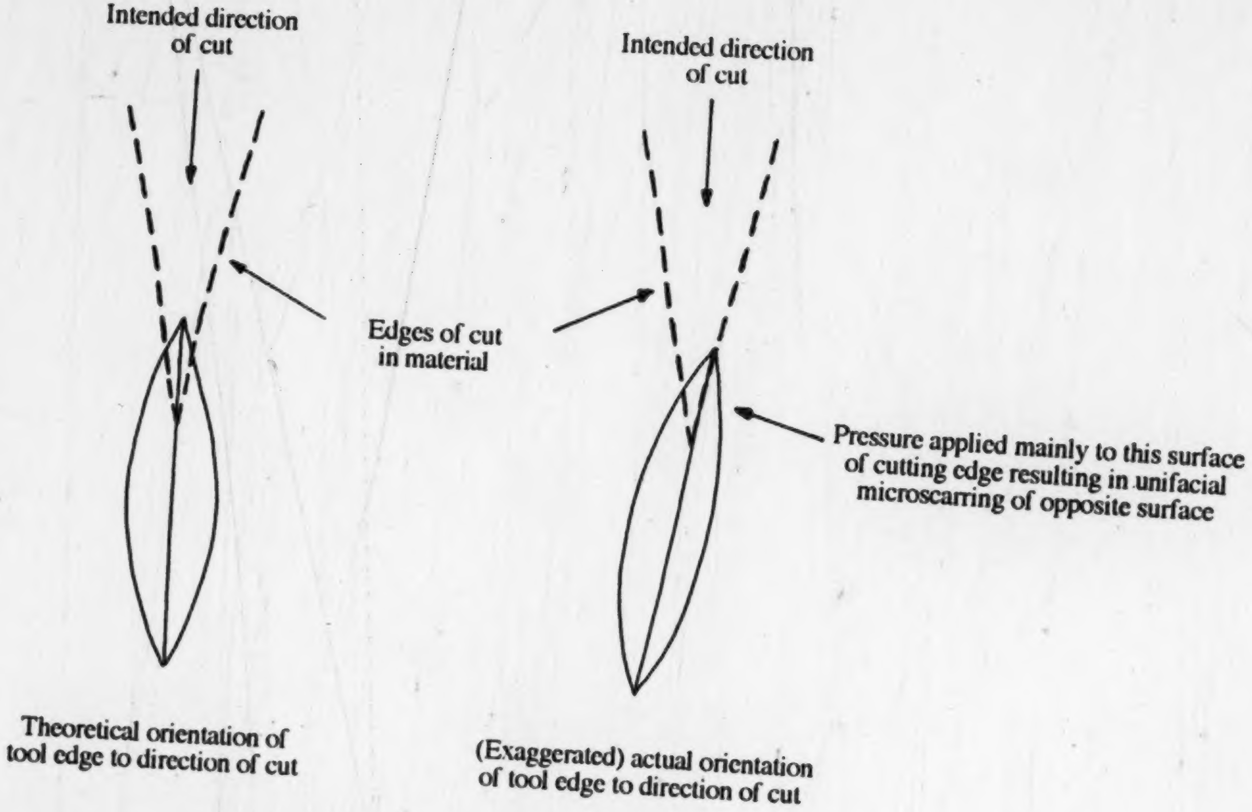

Intended direction of cut
Intended direction of cut
Edges of cut in material
Pressure applied mainly to this surface of cutting edge resulting in unifacial microscarring of opposite surface
Theoretical orientation of tool edge to direction of cut
(Exaggerated) actual orientation of tool edge to direction of cut

Figure 6.7 Illustration of the underside view of a flake tool cutting through task material showing a slightly oblique orientation of the tool edge to the direction of the cut resulting in unifacial wear, mainly on the trailing end.

A major point that is to be stressed following this experimentation is that, in the low-powered examination of potentially utilized flakes with limited edge-damage, it is **patterning** of the damage rather than the simple presence of damage, whatever the form, that should be the most important criterion in the interpretation of cause of damage. This is because it is the nature of edge-damage rather than the simple presence of some that allows the distinction between actual use-wear and other potential causes of edge-damage such as trampling. Other potential indicators of use-wear such as striations, which do not necessarily require patterning to be diagnostic, are not readily visible under low-power magnification.

All of the flakes in Part A were applied as cutting tools to soft materials. Only two of these flakes acquired edge-damage to a degree that might be recognizable as use-wear in an archaeological assemblage without aid of magnification. The other seven, or almost 80% of the total, would undoubtedly have gone either unrecognized as utilized or else the level of edge-damage would not have provided the analyst enough confidence to include them in this category without some further examination.

With magnification, seven of the nine flakes acquired what was categorized as minor wear. It is suggested here that identifying this level of edge-damage as being use-wear is likely, but a certain level of experience on the part of the analyst may be required to attain a level of consistency.

Of the 54 flakes used in Part B of the experimentation, only nine were observed, without magnification, to have a level of wear that might be recognizable as use-wear if observed in an archaeological assemblage. All nine of these flakes had been applied to hard materials (wood or antler) and seven of these nine had been applied in scraping tasks. This was as anticipated and discussed in the section 6.2, Thesis Experimentation. This suggests that more than 80% of the flakes utilized in this part of the experimentation would likely go unrecognized in an archaeological assemblage and in fact all of the flakes that had been applied to either soft or medium materials would have likely gone unrecognized.

Under magnification, 31 of the 54 flakes were seen to have minor to extensive edge-damage and would have been either easily identifiable as utilized or would likely to have been identified as utilized. This suggests that perhaps 45% or more of flakes that are utilized may not be identifiable even with low-power microscopic examination. Of the 31 flakes with minor to extensive edge-damage, 18 had been applied to hard materials, seven to medium, and six to soft materials. Of the 23 with negligible or no discernible wear, five (21.7%) were applied to medium and 18 (78.3%) to soft materials. This would indicate that of these experimental flakes with too little edge-damage to be identified as utilized, even with low-power microscopic examination, approximately 80% are flakes applied to soft materials such as meat or tubers.

Of the 16 flakes applied to scraping tasks, 13 (81.3%) acquired minor to extensive wear and 3 (18.8) acquired negligible to no discernible wear. Based on the experimental data here, of those flakes applied to scraping tasks 80% or more are likely to be identified as utilized under low-power magnification examination.

Of the 38 flakes applied to cutting tasks, 18 (47.4%) acquired minor to extensive wear and 20 (52.6%) acquired negligible to no discernible wear. Based on these data, of those flakes applied to cutting tasks there is roughly a 50% probability that a flake can be identified as utilized under low-power magnification examination.

Chapter 7 Analysis of Archaeological Samples

7.1 Methodology

7.1.1 Microscopic Examination

Microscopic examination of both the experimentally produced flakes and the sample flakes taken from the three archaeological assemblages was carried out with a simple stereoscopic microscope with a set magnification power of 20X (see Chapter 6 under Microscopic Examination for a description of the microscope used). Initial examination of each flake from the archaeological samples was carried out under good laboratory lighting without aid of magnification for two purposes. The first purpose was to attempt to locate any visible edge damage or irregularities that might be wear but could not be identified as such without magnification. Any such damage was then given specific attention during examination with magnification. The second purpose was to locate those margins or portions of margins that, due to morphology or relation to other features on the flake, would seem the most serviceable edges and those margins or portions of margins that would not seem to be serviceable. In practice all margins of each flake were examined to some extent under the microscope, but less effort was spent in examining flake margins that appeared to be unsuitable for application to any conceivable tasks.

The recording and quantification of any edge damage here was similar to that laid out in Chapter 6 on Experimentation. However, Degree of Wear category (which is used here as the best measure of the general visibility of edge-damage) was simplified for application to archaeological assemblages. Because, unlike the experimental flakes, the actual histories of the archaeological flakes are not known, more general descriptors of degree of damage are suggested.

None of the descriptors used in Degree of Wear in the experimental section are suggested here to be associated with any specific applications or types of applications of flake tools. If others accept the suggestion of this thesis that more effort is warranted in the detection of utilized flakes and they wish to address task-specific edge-damage, more experimentation and, likely, a different quantification system are required. If others simply wish to make general quantifications of presence/absence of utilized flakes the descriptors used here (No Observable Wear, Minor Wear, and Substantial Wear) should be suitable.

For actual measurements of flake scars, etc. a simple metric ruler with 1 millimeter incremental lines was held under the microscope next to the flake margin in question. This allowed the measure of the length of contiguous sections of damage, the dimensions of small flake scars, and allowed the estimate of the dimensions of individual microscars.

For each flake examined a catalogue form was filled out (see Appendix A). On this form was recorded details of the individual flake's completeness, dimensions, weight, and spine-plane angle(s). Notes were made about any observations made without aid of magnification. Then, following examination with magnification, if any wear or damage was observed, detailed notes were made about the specific location on the flake, the type of wear/damage and the extent of the wear/damage.

Attributes commonly recorded for both the experimental flakes and the archaeological samples included flake dimensions, weight, and spine-plane angles. In the case of the experimental flakes the plan view shape of the working edge and edge length were recorded as well. These attributes were not recorded in the initial analysis of the entire archaeological assemblages of the three case sites. Maximum dimension is the only attribute commonly recorded for both the experimental and sample flakes examined and the whole of the archaeological assemblages. Therefore size is the only attribute that can be systematically investigated here as a criterion for flake tool selection by prehistoric individuals in the archaeological assemblages.

It is suggested here that distribution of assemblages of utilized flakes in categories by individual weight would follow very closely any patterns observed in distribution based on individual size. This seems logical because of the high degree of correlation existing between size and weight. It also seems that, when dealing with hand-held tools as small as most flakes, weight would not likely be a factor in the conscious selection of flakes as tools.

7.2 Results of Examination

It must be kept in mind that all the flakes included in the three archaeological samples had been previously examined (without aid of magnification) during the general analysis for the purposes of satisfying the lithic analysis requirements for the respective site archaeological permit reports. None of these sample flakes had been identified as having any observable wear that would have indicated that they had been utilized. In the case of all three sites this initial general analysis had been carried out by several different individuals with varying degrees of training and experience in lithic analysis. This included several individuals who have carried out lithic analysis both professionally and in their graduate programs. It also included individuals who had had little or no previous experience but had undergone a certain amount of training and had ongoing supervision during the analysis of these specific assemblages. The fairly consistent percentage of each assemblage that was initially identified as utilized (with the relatively high percentage [13%] of utilized flakes identified in the Early Prehistoric assemblage of Site 243R being the exception) would tend to suggest that the quality of analysis was comparable between the three assemblages and that it might be viewed as typical.

The respective sample sizes from the Early Prehistoric populations for the three sites are: 8.9% for the subsample from Site EkPu-8, 6.0% for Site 243R, and 41.5% from the 1996 excavations at Site 1626R. This is quite a substantial range. Criticisms could be expressed with regard to the discrepancies in the relative sample sizes taken from the three sites and, more specifically, the different periods for each site.

This potential problem can be overcome by combining the data from the three sites

three sites (with a combined sample size of 10.6%) and the other with all the Middle Prehistoric data (with a combined sample size of 5.0%). Individual results for the three archaeological assemblages, specifically in the percentages of flakes with edge damage observed under the microscope, are similar enough so as to indicate little, if any, inter-site variability based on this variable. Of the total number of flakes examined under the microscope, 53.2% from Site 243R exhibited some edge damage, compared to 72.0% for Site EkPu-8 and 63.6% for Site 1626R. The limited range of these results should preclude any argument that variability between the sites would be masked by their being combined and that the general interpretations made here, based on this combined data, would be suspect. As the purpose of this thesis is to demonstrate the potential for tools to go unidentified in assemblages and not to go into the detailed analysis of the implications of this for specific assemblages, combining the site assemblages here is seen as innocuous. Obviously, any individual interpretations of each of these sites, based on the percentage of unmodified flake tools, would require a separation, and potentially a comparison, of the different frequencies of these tools observed in each assemblage.

7.2.2 Early Prehistoric Sample

The number of Early Prehistoric debitage items from the three sites (or that data specifically included - see chapter on sample selection) totaled n=1291 items of clastic sedimentary debitage. Of the 946 that were ≥ 10 mm and not initially identified as having use-wear, 100 (10.6%) were selected out for microscopic analysis.

Of the 100 flakes included in the Early Prehistoric sample, 67 or 67.0%, had some observable edge damage that was comparable in type, nature and extent to that observed on the experimentally produced and utilized flakes.

Table 7.1. Total debitage population, by size class, examined from the Early Prehistoric assemblages of all three archaeological sites and the number in each size class that exhibited any edge damage at 20X magnification.

Size Class	Freq.	% of assemb.	# Flakes examined	% of Size Class	% of total assemb.	# examined w edge-wear	% examined w edge-wear
>10 ≤ 15	372	**39.6**	9	2.4	1.0	5	55.6
>15 ≤ 20	242	**25.6**	25	10.3	2.6	16	64.0
>20 ≤ 25	125	**13.2**	10	8.0	1.1	5	50.0
>25 ≤ 30	96	**10.1**	19	19.8	2.0	14	73.7
>30 ≤ 35	49	**5.2**	16	32.7	1.7	13	81.3
>35 ≤ 40	23	**2.4**	4	17.4	0.4	3	75.0
>40 ≤ 50	25	**2.6**	12	48.0	1.3	7	58.3
>50 ≤ 60	8	**0.8**	4	50.0	0.4	3	75.0
>60 ≤ 70	2	**0.2**	1	50.0	0.1	1	100.0
>70 ≤ 80	0	**0.0**	0	0.0	0.0	0	0.0
>80 ≤ 90	0	**0.0**	0	0.0	0.0	0	0.0
> 90	1	**0.1**	0	0.0	0.0	0	0.0
Total	946	**100%**	100	10.6%	10.6%	67	67.0%

7.2.2.1 Taking Size into Account

As size has been identified as an important factor in the selection of flakes as hand-held tools it is necessary that this be taken into account when comparing the observations made here with other archaeological assemblages. As the samples were taken from populations defined on the basis of size (and edge-morphology), any patterning in the samples is comparable only to flakes that also satisfy these criteria. Table 7.1 provides a summary of the number of flakes included in the samples from each size class and the general results of the number and percentage of these that exhibited some edge damage.

However, Table 7.2 provides a more insightful way of viewing the influence of size on flake tool selection. It is interesting that with the incremental decrease in debitage size, from 50 millimeters and smaller, there is not a coinciding decrease in the percentage of edge-damaged flakes.

Table 7.2. Sample size by cumulative size class and the frequency and percent frequency of damaged flakes in each size class sample for the Early Prehistoric assemblages of all three sites.

Inclusive Size Class	Total Number in size class	number of flakes included in sample	number in sample as % of total	number of sample flakes with damage	percent of sample with damage
>60	5	1	20.0	1	100.0
>50	13	5	38.5	4	80.0
>40	45	17	37.8	11	64.7
>35	74	21	28.4	14	66.7
>30	133	37	27.8	27	73.0
>25	238	56	23.5	41	73.2
>20	380	66	17.4	46	69.7
>15	640	91	14.2	63	69.2
>10	1026	100	9.7	67	67.0

The percentage of edge-damaged flakes remains remarkably constant between the sample representing all debitage >5 mm and the sample representing all debitage >40 mm. This suggests that, in the total debitage population, the liklihood of having edge damage is relatively constant for all debitage < 50 mm in maximum dimension (Thomas 1976, 443). Disregarding sample size for a moment, the data suggest that for debitage items greater than 50 millimeters in maximum dimension there is an 80 % or greater chance that they will have edge-damage. For all debitage items less than 50 millimeters in maximum dimension (but ≥ 10 mm) the chance of having edge-damage is between approximately 65 % and 75 %.

Sample size is a factor for at least the >60 size class data and to a lesser degree for the >50 size class as well. The percentage of flakes in these two classes that were included in the sample are quite high, 20.0% and 38.5% respectively. The actual frequencies are, however, quite low and the addition to either size class of even a single flake could significantly change the results.

If these results are extended to the entire assemblage population, out of the 946 items, between 615 and 710 might be expected to have some observable edge-damage. (Of course, as was noted during the sample selection, a portion of these flakes will either not be morphologically suitable for any conceivable tasks or will be of a poorly consolidated raw material any edge-damage to which is unreadable).

7.2.2.2 Taking Degree of Observed Edge-Damage into Account

With the inclusion among the edge-damaged flakes tabulated in Table 7.3 of those items that exhibited minor edge damage the degree of confidence that might be expressed that what is being observed is actually use-wear, decreases substantially. The descriptor, minor edge damage, as observed on these items, is based on the observation among the experimental flakes of comparable edge damage. It is suggested here that this level of damage on the archaeological assemblages is likely the result of utilization.

However, it must also be acknowledged here that any decrease in observable patterning in edge-damage necessarily translates into a decrease in the level of confidence that the damage is genuine use-wear. Greater magnification would undoubtedly increase the ability to observe any patterning that might be present, but one of the goals of this thesis is to suggest a practical method of examination which will substantially increase our ability to detect unmodified flake tools and yet try to avoid the necessity for substantial investments of time and money.

The categories of levels of observed edge-damage used here are unavoidably arbitrary. Different analysts and researchers may have alternative opinions of where the boundaries between different levels of wear should be placed. I suggest that the category, substantial edge damage, as it is defined in this thesis, represents a level of patterning to edge damage that, in comparison to the experimentally produced flakes, can confidently be attributed to actual utilization.

Table 7.3. Summary of size distribution of Early Prehistoric samples from all three archaeological sites and the frequencies of various observed levels of edge damage.

Size Class	Total Number	N no observable wear	N minor wear	N substantial wear
>10 ≤ 15	9	4	2	3
>15 ≤ 20	25	9	7	9
>20 ≤ 25	10	5	3	2
>25 ≤ 30	19	5	6	8
>30 ≤ 35	16	3	1	12
>35 ≤ 40	4	1	1	2
>40 ≤ 50	12	5	1	6
>50 ≤ 60	4	1	0	3
>60 ≤ 70	1	0	0	1
Total	100	33	21	46

With the exclusion of those items with minor edge damage the number of flakes that might confidently be identified as utilized drops to 46 or 46.0% of the total sample of Early Prehistoric debitage. Extending this result to the total Early

Prehistoric debitage population, it could be anticipated that upwards of approximately 435 flakes (946 x 46.0% = 435.2) had been utilized.

Table 7.4. Sample size by cumulative size class and the frequency and percent frequency of flakes with substantial edge-damage in each size class sample for the Early Prehistoric assemblages of all three sites.

Inclusive Size Class	Total Number in size class	number of flakes included in sample	number in sample as % of total	# of sample flakes with >minor damage	percent of sample with >minor damage
>60	5	1	20.0	1	100.0
>50	13	5	38.5	4	80.0
>40	45	17	37.8	10	58.8
>35	74	21	28.4	12	57.1
>30	133	37	27.8	24	64.9
>25	238	56	23.5	32	58.2
>20	380	66	17.4	34	51.5
>15	640	91	14.2	43	47.3
>10	1026	100	9.7	46	46.0
>5	1265	100	7.9	46	46.0

Table 7.4 indicates that by including only those sample flakes with more than just minor edge-damage the probability, depending on size, of having edge-damage changes, but not substantially. The chance of a flake > 50 mm in maximum dimension having substantial edge-damage remains at 80% or greater. For flakes < 50 mm, the chance of having substantial edge-damage is, as would be expected, less than the chance of having any level of damage. The decrease in liklihood is, however, on average only 19.4%. If extended to the whole Early Prehistoric debitage population, this would suggest that of the 946 items, between 435 and 614 would have been utilized.

Table 7.5. The frequency of combined Early Prehistoric sample flakes with any edge-damage, the frequency of flakes with substantial edge-damage and the percentage the latter is of the former.

inclusive Size Class	# of sample flakes with edge-damage	# of flakes with >minor edge-damage	% of damaged flakes with >minor damage
>60	1	1	100.0
>50	4	4	100.0
>40	11	10	90.9
>35	14	12	85.7
>30	27	24	88.9
>25	41	32	78.0
>20	46	34	73.9
>15	62	43	69.4
>10	66	46	69.7
>5	67	46	68.7

Table 7.5 indicates the liklihood, depending on size, that a flake with edge-damage will have substantial edge-damage. It is clear that there is a tendency, though not absolutely consistent, that the larger the flake the more likely it is to acquire a greater amount of edge damage with a higher degree of patterning.

7.2.3 Middle Prehistoric Sample

The Middle Prehistoric assemblages of the three sites (or that data specifically included - see chapter on sample selection) included 3217 items of debitage. Of the 1971 flakes that wer ≥ 10mm and not initially identified as having use-wear, 99 (5.0%) were selected out for microscopic analysis. This is a significantly smaller sample than that taken for the Early Prehistoric materials, but as previously mentioned the interest of this thesis was greater with respect to the Early Prehistoric Period. Of these 99 sample flakes, 61 or 61.6%, had some observable edge damage that was comparable in type, nature and extent to that observed on the experimentally produced and utilized flakes. This is a number comparable to that observed in the Early Prehistoric assemblage.

Table 7.6. Total debitage population, by size class, examined from the Middle Prehistoric assemblages of all three archaeological sites and the number in each size class that exhibited any edge damage at 20X magnification.

Size Class	Freq.	% of assemb.	# Flakes examined	% of Size Class	% of total assemb.	# examined w edge-wear	% examined w edge-wear
>10 ≤ 15	926	**47.0**	0	0.0	0.0	0	0.0
>15 ≤ 20	526	**26.7**	11	2.1	0.6	8	72.7
>20 ≤ 25	227	**11.5**	22	9.7	1.1	14	67.0
>25 ≤ 30	115	**5.8**	20	17.4	1.0	10	50.0
>30 ≤ 35	82	**4.2**	13	15.9	0.7	9	69.2
>35 ≤ 40	51	**2.6**	15	29.4	0.8	8	53.3
>40 ≤ 50	29	**1.5**	14	48.3	0.7	9	64.3
>50 ≤ 60	8	**0.4**	3	37.5	0.2	2	67.0
>60 ≤ 70	4	**0.2**	1	25.0	0.05	1	100.0
>70 ≤ 80	2	**0.1**	0	0.0	0.0	0	0.0
>80 ≤ 90	1	**0.05**	0	0.0	0.0	0	0.0
> 90	0	**0.0**	0	0.0	0.0	0	0.0
Total	1971	**100%**	99	5.0%	5.0%	61	61.6%

7.2.3.1 Taking Size into Account

Table 7.6 provides a summary of the number of flakes included in the samples from each size class and the general results of the number and percentage of these that exhibited some edge damage, but as discussed above, Table 7.7 provides a more insightful way of viewing the influence of size on flake tool selection. In the case of the Middle Prehistoric data in Table 7.7 there is, as with the Early Prehistoric data, a distinct plateau of consistent percentages of edge-damaged flakes in the classes of smaller flake sizes with a distinct rise in the percentages for the largest size classes. With the Middle Prehistoric data, however, the line between these is less distinct, and might be drawn at 40 mm rather than 50 mm. Based on Table 7.7 the chance of a flake > 40 mm in maximum dimension having edge-damage is 66.7% or higher.

Table 7.7. Samples sizes by cumulative size class and the frequency and percent frequency of damaged flakes in each size class sample for the Middle Prehistoric assemblages of all three sites.

inclusive Size Class	Total Number in size class	number of flakes included in sample	number in sample as % of total	number of sample flakes with damage	percent of sample with damage
>60	7	1	14.3	1	100.0
>50	18	4	22.2	3	75.0
>40	52	18	34.6	12	66.7
>35	109	33	30.3	20	60.6
>30	200	46	23.0	29	63.0
>25	321	66	20.6	39	59.1
>20	562	88	15.7	53	60.2
>15	1100	99	9.0	61	61.6
>10	2034	99	4.9	61	61.6

The data also suggest that the liklihood of having edge damage is relatively constant for all debitage < 40 mm in maximum dimension (not including items < 10 mm). The liklihood of all flakes < 40 mm (not including items < 10 mm) having edge-damage is approximately 60%.

If these results are extended to the entire debitage population, out of the 1971 items that are ≥ 10 mm but < 40 mm in maximum dimension, approximately 1180 might be expected to have some observable edge-damage. Of those 77 flakes that are > 40 mm in maximum dimension at least 58 will likely have edge-damage.

7.2.3.2 Taking Degree of Observed Edge-Damage into Account

With the exclusion of those items with greater than minor edge damage the number of flakes that might confidently be identified as utilized drops to 42.4% of the total sample of Middle Prehistoric debitage. Extending this result to the total Middle Prehistoric debitage population, it could be anticipated that upwards of approximately 836 flakes (1971 x 42.4% = 835.7) had been utilized.

Table 7.8. Summary of Middle Prehistoric samples from all three archaeological sites and the frequencies of various observed levels of edge damage.

Size Class	Total Number	N no observable wear	N minor wear	N substantial wear
>10 ≤ 15	0	0	0	0
>15 ≤ 20	6	3	2	6
>20 ≤ 25	13	8	2	12
>25 ≤ 30	10	10	6	4
>30 ≤ 35	8	4	4	5
>35 ≤ 40	12	7	2	6
>40 ≤ 50	14	5	2	7
>50 ≤ 60	3	1	1	1
>60 ≤ 70	0	0	0	1
Total	99	38	19	42

In Table 7.9, when including only those sample flakes with more than just minor edge-damage, the line between the percentage of larger flakes with damage and the smaller flakes with damage is at 60 mm. The data presented suggest that 100% of flakes >60 mm are likely to have substantial edge-damage. However, (as is the case in the Early Prehistoric assemblage) while the *percentage* of flakes in the two classes of largest flakes (>50 and >60 mm) that were included in the sample are quite high, 22.2% and 14.3% respectively, the *actual* numbers are low. Even a single addition to either size class could significantly change the results as they are now.

Table 7.9. Sample size by cumulative size class and the frequency and percent frequency of flakes with substantial edge-damage in each size class sample for the Middle Prehistoric assemblages of all three sites.

inclusive Size Class	Total Number in size class	number of flakes included in sample	number in sample as % of total	# of sample flakes with >minor damage	percent of sample with >minor damage
>60	7	1	14.3	1	100.0
>50	18	4	22.2	2	50.0
>40	52	18	34.6	9	50.0
>35	109	33	30.3	15	45.5
>30	200	46	23.0	20	43.5
>25	321	66	20.6	24	36.4
>20	562	88	15.7	36	40.9
>15	1100	99	9.0	42	42.4
>10	2034	99	4.9	42	42.4
>5	3060	99	3.2	42	42.4

The chance of flakes between 40 and 60 mm in maximum dimension having substantial edge-damage is approximately 50%. For all flakes < 40 mm and > 5 mm, the liklihood of having substantial edge-damage is around 40.0%. If these results are extended to the whole Middle Prehistoric debitage population, this would suggest that of the 60 items < 60 and > 40 mm, 30 would likely have significant edge damage. For items < 40 and ≥ 10 mm in maximum dimension, approximately 788 (40.0% x 1971 = 788.4) would have been utilized.

Table 7.10. The frequency of combined Middle Prehistoric sample flakes with any edge-damage, the frequency of flakes with substantial edge-damage and the percentage the latter is of the former.

inclusive Size Class	# of sample flakes with edge-damage	# of flakes with >minor edge-damage	% of damaged flakes with >minor damage
>60	1	1	100.0
>50	3	2	66.6
>40	12	9	75.0
>35	20	15	75.0
>30	29	20	69.0
>25	39	24	61.5
>20	53	36	67.9
>15	61	42	68.9
>10	61	42	68.9
>5	61	42	68.9

Table 7.10 indicates the liklihood, depending on size, that a flake with any edge-damage will have substantial edge-damage. Again, as with the Early Prehistoric assemblage, it is clear that there is a tendency, though not absolutely consistent, that the larger the flake the more likely it is to acquire a greater amount of edge damage with a higher degree patterning. As mentioned above, for the one or two classes of largest flake sizes, sample size makes the results tenuous. The rest of the size classes, however, have sample sizes that should allow a relatively high level of confidence.

7.2.4 Summary of Analysis of the Archaeological Samples

Early Prehistoric Assemblages

Tables 7.11, 7.12, and 7.13 provide a general summary of the results of the analysis of the Early Prehistoric assemblages from the initial site analysis of my selected sample, as carried out by others, and my microscopic examination of the same selected samples.

Table 7.11 Frequency and percentage of Early Prehistoric clastic sedimentary debitage and utilized flakes from the total Site EkPu-8 sub-assemblage.

Size Class	Freq.	% of assem.	used flakes visual ID	used flakes ID'ed at 20X	total used flakes ID'ed	% of Size Class
≤5 mm	5	0.5	0	0	0	0.0
>5 ≤ 10	177	16.1	0	0	0	0.0
>10 ≤ 15	337	30.7	0	5	5	1.5
>15 ≤ 20	226	20.6	0	11	11	4.9
>20 ≤ 25	134	12.2	2	4	6	4.5
>25 ≤ 30	98	8.9	1	13	14	14.3
>30 ≤ 35	54	4.9	1	12	13	24.1
>35 ≤ 40	26	2.4	1	3	4	15.4
>40 ≤ 50	29	2.6	2	6	8	27.6
>50 ≤ 60	8	0.7	2	3	5	62.5
>60 ≤ 70	3	0.3	1	1	2	66.7
>70 ≤ 80	1	0.09	1	0	1	100.0
>80 ≤ 90	0	0.0	0	0	0	0.0
> 90	1	0.09	0	0	0	0.0
Total	1099	100 %	11	58	69	6.3%

Table 7.12 Frequency and percent frequency of Early Prehistoric clastic sedimentary debitage and utilized flakes from the Site 243R.

Size Class	Freq.	% of assem.	used flakes visual ID	used flakes ID'ed at 20X	total used flakes ID'ed	% of Size Class
≤5 mm	5	5.4	0	0	0	0.0
>5 ≤ 10	26	28.3	2	0	2	7.7
>10 ≤ 15	24	26.1	4	0	4	16.7
>15 ≤ 20	24	26.1	4	0	4	16.7
>20 ≤ 25	4	4.3	1	0	1	25.0
>25 ≤ 30	4	4.3	1	0	1	25.0
>30 ≤ 35	2	2.2	0	0	0	0.0
>35 ≤ 40	2	2.2	0	0	0	0.0
>40 ≤ 50	1	1.1	0	0	0	0.0
>50 ≤ 60	0	0.0	0	0	0	0.0
>60 ≤ 70	0	0.0	0	0	0	0.0
>70 ≤ 80	0	0.0	0	0	0	0.0
>80 ≤ 90	0	0.0	0	0	0	0.0
> 90	0	0.0	0	0	0	0.0
Total	92	100 %	12	0	12	13.0%

Table 7.13 Frequency and percent frequency of Early Prehistoric clastic sedimentary debitage and utilized flakes from Site 1626R.

Size Class	Freq.	% of assem.	used flakes visual ID	used flakes ID'ed at 20X	total used flakes ID'ed	% of Size Class
≤5 mm	6	6.7	0	0	0	0.0
>5 ≤ 10	36	40.0	0	0	0	0.0
>10 ≤ 15	25	27.8	1	0	1	4.0
>15 ≤ 20	10	11.1	0	7	7	70.0
>20 ≤ 25	4	4.4	0	2	2	50.0
>25 ≤ 30	3	3.3	0	2	2	67.0
>30 ≤ 35	3	3.3	1	1	2	67.0
>35 ≤ 40	1	1.1	0	0	0	0.0
>40 ≤ 50	2	2.2	0	1	1	50.0
>50 ≤ 60	0	0.0	0	0	0	0.0
>60 ≤ 70	0	0.0	0	0	0	0.0
>70 ≤ 80	0	0.0	0	0	0	0.0
>80 ≤ 90	0	0.0	0	0	0	0.0
> 90	0	0.0	0	0	0	0.0
Total	90	100 %	2	13	15	16.7%

For two of the sites the microscopic analysis increased the number of identified edge-damaged flakes substantially. The percentage of edge-damaged flakes identified in the Site EkPu-8 sub-assemblage was increased from 1.0% to 6.3% and in the Site 1626R assemblage this increase is from 2.2% to 16.7%. When the assemblages are broken down by size increments these increases are more substantial. For example, in the Site 1626R assemblage the percentage of identified edge-damaged flakes >10 mm increases from 4.2% to 31.3% and for those >15 mm the increase is from 4.3% to 60.9%.

For Site 243R there is no increase in the number or percentage of identified edge-damaged flakes. This likely due mainly to the small sample size (3 out of 92) that was examined under the microscope.

The combined data from the three sites indicates that the liklihood of a flake between 50 and 10 millimeters in maximum dimension having edge damage is between 50% and 65% while the chance of a flake >50 mm having edge-damage is 80+%. The likelihood of larger flakes having edge-damage and, in fact having more edge-damage, is relatively constant.

Extrapolating the results of the examination of the samples to the collective Early Prehistoric debitage population, the potential number of flakes with greater than minor edge-damage would be approximately half of the total number of flakes > 10 mm in maximum dimension.

Middle Prehistoric Assemblages

Tables 7.14, 7.15, and 7.16 provide a general summary of the results of the analysis of the Middle Prehistoric assemblages from the initial site analysis carried out by others and the microscopic examination of the selected samples.

Table 7.14 Frequency and percentage of Middle Prehistoric clastic sedimentary debitage and utilized flakes from the Site EkPu-8 sub-assemblage.

Size Class	Freq.	% of assem.	used flakes visual ID	used flakes ID'ed at 20X	total used flakes ID'ed	% of Size Class
≤5 mm	0	0.0	0	0	0	0.0
>5 ≤ 10	30	20.8	0	0	0	0.0
>10 ≤ 15	52	36.1	0	0	0	0.0
>15 ≤ 20	32	22.2	0	0	0	0.0
>20 ≤ 25	13	9.0	0	2	2	15.4
>25 ≤ 30	8	5.6	0	3	3	37.5
>30 ≤ 35	4	2.8	1	0	1	25.0
>35 ≤ 40	3	2.1	1	0	1	33.3
>40 ≤ 50	2	1.4	0	1	1	50.0
>50 ≤ 60	0	0.0	0	0	0	0.0
>60 ≤ 70	0	0.0	0	0	0	0.0
>70 ≤ 80	0	0.0	0	0	0	0.0
>80 ≤ 90	0	0.0	0	0	0	0.0
> 90	0	0.0	0	0	0	0.0
Total	144	100 %	2	6	8	5.6%

Table 7.15 Frequency and percent frequency of Middle Prehistoric clastic sedimentary debitage and utilized flakes from the Site 243R.

Size Class	Freq.	% of assem.	used flakes visual ID	used flakes ID'ed at 20X	total used flakes ID'ed	% of Size Class
≤5 mm	150	5.4	0	0	0	0.0
>5 ≤ 10	942	33.7	0	0	0	0.0
>10 ≤ 15	794	28.4	7	0	7	0.9
>15 ≤ 20	444	15.9	9	4	13	2.9
>20 ≤ 25	191	6.8	11	7	18	9.4
>25 ≤ 30	101	3.6	5	4	9	8.9
>30 ≤ 35	79	2.8	6	5	11	13.9
>35 ≤ 40	50	1.8	4	7	11	22.0
>40 ≤ 50	31	1.1	4	8	12	38.7
>50 ≤ 60	11	0.4	3	3	6	54.5
>60 ≤ 70	3	0.1	0	0	0	0.0
>70 ≤ 80	2	0.07	0	0	0	0.0
>80 ≤ 90	1	0.04	0	0	0	0.0
> 90	0	0.0	0	0	0	0.0
Total	2798	100 %	49	38	87	3.1%

Table 7.16 Frequency and percent frequency of Middle Prehistoric clastic sedimentary debitage and utilized flakes from the Site 1626R.

Size Class	Freq.	% of assem.	used flakes visual ID	used flakes ID'ed at 20X	total used flakes ID'ed	% of Size Class
≤5 mm	7	2.6	0	0	0	0.0
>5 ≤ 10	54	19.7	0	0	0	0.0
>10 ≤ 15	88	32.1	1	0	1	1.1
>15 ≤ 20	62	22.6	3	5	8	12.9
>20 ≤ 25	37	13.5	3	5	8	21.6
>25 ≤ 30	12	4.4	1	4	5	41.7
>30 ≤ 35	8	2.9	2	3	5	62.5
>35 ≤ 40	4	1.5	1	3	4	100.0
>40 ≤ 50	1	0.4	1	0	1	100.0
>50 ≤ 60	0	0.0	0	0	0	0.0
>60 ≤ 70	1	0.4	0	1	1	100.0
>70 ≤ 80	0	0.0	0	0	0	0.0
>80 ≤ 90	0	0.0	0	0	0	0.0
> 90	0	0.0	0	0	0	0.0
Total	275	100 %	12	21	33	12.0%

In the case of the Middle Prehistoric assemblages of all three of the sites the microscopic analysis increased the number of identified edge-damaged flakes to some degree. The percentage of edge-damaged flakes identified in the Site EkPu-8 sub-assemblage was increased from 1.4% to 5.6% and in the Site 1626R assemblage this increase is from 4.4% to 12.0%. The magnitude of these increases is very similar to the increases noted for the Early Prehistoric assemblages of the same two sites. This may be an indication of specific site types or activities. There is an increase in the percentage of identified flakes, 1.8% to 3.1%, for the Middle Prehistoric assemblage from Site 243R, however, it is still significantly lower than that of the other two sites.

As with the Early Prehistoric assemblages, when size is taken into account the increase in identification is much more substantial. For example, in the Site 243R assemblage the percentage of identified edge-damaged flakes >30 mm increases from 9.7% to 22.7% and for those >40 mm the increase is from 14.9% to 38.3%.

The combined data from the three sites indicates that the liklihood of a flake between 50 and 10 millimeters in maximum dimension having edge damage is between approximately 60% and 70% while the probability of a flake >50 mm having edge-damage is 75+%.

Extrapolating the results of the examination of the samples to the collective Middle Prehistoric debitage population, the potential number of flakes with greater than minor edge-damage would be approximately 60% of the total number of flakes > 10 mm in maximum dimension.

That an item is simply a flake of stone (even if the raw material is suitable for stone tool manufacture or use) is obviously not necessarily a sufficient criterion for it to be selected for use as a tool. Other factors such as size and edge morphology undoubtedly play a role in the individual selection of flakes for specific task applications. Furthermore, if the flakes are not being produced specifically for application as tools (e.g., during the production of bifacial tools) then they may never be utilized no matter how suitable for any number of tasks.

The suggestion in this thesis is that, based on the high percentages of flakes of materials that are different than those most often used for the manufacture of formal tools in the three Eastern Slopes sites included here, the flakes of the local clastic sedimentary material were most likely specifically produced as expedient, unmodified flakes tools.

Table 8.1 Percentage of formal tools (bifaces and formed unifaces) in each total raw material assemblage from Early and Middle Prehistoric components of the three study sites.

	% of total lithic items, by raw material, that is comprised of formal tools		
Class of Material	Site EkPu-8	Site 1626R	Site 243R
clastic sedimentary	0.2	0.8	0.2
quartzite	1.0	1.2	2.4
chert/chalcedony	6.4	4.1	0.8

Table 8.1 illustrates that, while local clastic sedimentary materials such as silicified siltstone and silicified mudstone are by far the most dominant raw material types at these three sites (96.0% at EkPu-8, 92.6% at 1626R, and 87.3% at 243R), on average only 0.3% of these items are used for formal tools. Cryptocrystalline

materials, such as chert and chalcedony, account for 1.7% of the EkPu-8, 4.5% of the 1626R, and 7.5% of the 243R assemblages, but on average between the three sites 3.0% of these material are used for formal tools. This is ten times the frequency of use of the clastic sedimentary materials. Clastic sedimentary materials account, on average, for 64.6% and cryptocrystalline materials account for approximately 24% of all formal tools. Quartzite materials occur in quantities similar to the cryptocrystalline materials, but fall somewhere between these and the clastic sedimentary materials in utilization for formal tools. This may suggest that, whatever the actual nature of the respective uses of the cryptocrystalline and clastic sedimentary materials by prehistoric individuals, the use of quartzite materials may have overlapped both.

At site 243R it was noted that, of the cryptocrystalline material recovered, the majority was from a single concentration of pressure-flaked debitage that, due to their excessively small size, could not possibly have been utilized as unmodified flake tools. It seems likely that this concentration is the remains of the final stage(s) of production of a formal tool. Table 8.2 illustrates that when those individual items of debitage that could not possibly serve as either formal or unmodified tools are excluded from all raw material assemblages, the percentage of cryptocrystalline items that had been used as formal tools increases substantially more than the percentage of the other materials that were used for formal tools.

Table 8.2 Percentage of each raw material assemblage comprised of formal tools (bifaces and formed unifaces) in the three study sites, not including items ≤ 5 mm in maximum dimension.

	% of total lithic items, by raw material, that is comprised of formal tools		
Class of Material	Site EkPu-8	Site 1626R	Site 243R
clastic sedimentary	0.3	0.9	0.3
quartzite	1.1	1.3	2.4
chert/chalcedony	8.0	4.6	4.3

Given the low frequency of usage of clastic sedimentary for formal tools and yet the very high frequency of these materials in the site, it seems reasonable to suggest that the people at these sites were producing quantities of flakes for use as unmodified tools.

The results of the examination of the archaeological samples for edge-damage (Chapter 7) demonstrated that, while all flakes greater than 5 mm are more likely, than not, to have observable edge-damage (with microscopic aid or not), size is somewhat of an influencing factor in the selection of flakes as tools (see Tables 7.4 and 7.7). Overall, the larger the flake the more likely it is that it will have greater than minor edge-damage.

Therefore, if Early Prehistoric Eastern Slopes groups were concentrating on the production of unmodified flake tools out of the local clastic sedimentary materials, it would be expected that there should be a tendency for the assemblages of these materials to include more large flakes than the cryptocrystalline assemblages.

Table 8.3 Average maximum dimension of debitage in each raw material assemblage from the three study sites.

Class of Material	Site EkPu-8	Site 1626R	Site 243R	Average
clastic sedimentary	19.2	17.4	16.3	17.6
quartzite	20.0	15.9	13.7	16.5
chert/chalcedony	15.7	13.8	6.0	11.8

Table 8.3 indicates that there is in fact a definite tendency for cryptocrystalline debitage to be smaller on the average than the debitage in the other two material categories.

One aspect of note is the significant decrease in average size in the cryptocrystalline assemblage from Site 243R. This significantly lower average than those of the cryptocrystalline assemblages from the other two sites is due mainly to the presence of the concentration of chalcedony pressure-flaking debitage at Site 243R. The other two sites had nothing really comparable to this amount of fine quality material. The method of recovery differed in the collection of this concentration as well, as discussed below.

Table 8.4 also provides an illustration of the differences in size distribution of the debitage in the three raw material categories. The important comparison to be made here is of each size class between the three material types. The most significant differences, however, are between the sites.

Table 8.4 Percentage of debitage for each raw material assemblage from the three study sites that are >10 and > 5 mm in maximum dimension.

Class of Material	Site	% items >5 mm	% items >10 mm	% items >15 mm
clastic sedimentary	EkPu-8	99.7	80.6	47.0
	1626R	96.2	71.7	40.8
	243R	93.6	58.5	32.0
quartzite	EkPu-8	98.9	83.5	48.4
	1626R	93.8	75.0	37.5
	243R	98.0	43.6	17.8
chert/chalcedony	EkPu-8	100.0	70.0	28.8
	1626R	89.1	52.2	28.3
	243R	19.3	1.5	0.0

The percentage of debitage that is greater than 5 mm is relatively consistent in all three sites and all three material categories, with the notable exception of the cryptocrystalline debitage of Site 243R. Few items < 5 mm in maximum dimension tend to be recovered. Items of this size can fit through 1/4 inch (6 mm) mesh screen and this was the gauge of screen used in the main excavations of all three sites. Therefore, the exclusion of items of this size will tend not to greatly affect the overall assemblage totals. During excavations at Site 243R, upon discovery of the concentration of chalcedony, methodology was modified to suit the nature of the debitage and an 1/8 inch screen was employed. This resulted in the recovery of a higher percentage of < 5 mm items than occurred in the rest of the excavation of this site and the other two. In Site 243R the decrease in the percentage of cryptocrystalline debitage between the >5, > 10 mm and the >15 mm classes is obvious. Over 80% of the cryptocrystalline debitage from Site 243R is ≤ 5 mm in maximum dimension.

In the other two sites the same trend occurs but is less pronounced. In Site EkPu-8 the percentage of items >10 mm is 80.6 and 83.5 for the clastic sedimentary and quartzite categories respectively, but only 70% of the cryptocrystalline debitage is >10 mm. In other words, 30% of the cryptocrystalline debitage is ≤10 mm compared to 19.4 and 16.5 for the other two materials. In Site 1626R the percentage of items >10 mm is 71.7 and 75.0 for the clastic sedimentary and quartzite categories respectively, but only 52.2% of the cryptocrystalline debitage is >10 mm. At this site 47.8% of the cryptocrystalline debitage is comprised of items ≤10 mm, compared to 28.3 and 25.0% for the other materials.

In the >15 mm size class the distinction between the distributions of the materials is more pronounced. In Site EkPu-8 the percentage of items >15 mm is 47.0 and 48.4 for the clastic sedimentary and quartzite categories respectively, but only 28.8% of the cryptocrystalline debitage is >15 mm. In other words, over 70% of the cryptocrystalline debitage is ≤15 mm compared to 53% and 51.6% for the other two materials. In Site 1626R the percentage of items >15 mm is 40.8 and 37.5 for the clastic sedimentary and quartzite categories respectively, but only 28.3% of the cryptocrystalline debitage is >15 mm. Here as well, over 70% of the cryptocrystalline debitage is comprised of items ≤15 mm, compared to 50.2 and 62.5% for the other materials.

While these differences in size distributions might be attributable to different technologies and reduction strategies, it must be noted that they could also be the result of the form in which the raw materials are initially being acquired. If the prehistoric groups were acquiring cryptocrystalline materials in small pebble form, as might occur locally, then the potential size of removed flakes will be limited from the outset. However, the fact remains that for the production of formal tools, prehistoric people at these three sites preferred cryptocrystalline raw materials over the local clastic sedimentary materials, but were expending far more effort reducing the clastic sedimentary materials. Some production of formal tools from these materials occurred, but it seems likely that most of the reduction of clastic sedimentary materials at these sites was directed towards the production of flakes for use as unmodified tools. This means that utilized flakes may represent the majority of artifacts in these three sites and perhaps in other Eastern Slopes sites.

8.1 Initial Analysis of the Site Assemblages

In the initial analysis of the three archaeological assemblages, carried out for the site reports, the percentage of flakes that were identified as utilized was quite low for all three sites. For the whole of the Early and Middle Prehistoric assemblage from Site EkPu-8 (not just the sub-assemblage from which the samples for further analysis were selected - see Chapter 4 on Sample Selection) approximately 1.0% of the debitage was categorized as marginally retouched or utilized. In the Early and Middle Prehistoric assemblage from Site 1626R, 0.4% of the debitage was categorized as retouched and 1.3% were categorized as utilized for a total of 1.7%. In the Early and Middle Prehistoric assemblage from Site 243R 1.6% of the debitage was identified as retouched or utilized.

If all cryptocrystalline debitage is excluded (accepting that the cryptocrystalline materials were for formal tool production and unmodified flake tools would not be expressly produced from these materials) and all debitage <5 mm in maximum dimension are also excluded then the percentage of debitage categorized as retouched or utilized rises somewhat. For Site EkPu-8 the percentage of retouched or utilized flakes rises to just slightly above 1.0%, for Site 1626R the number rises to 2.1%, and for Site 243R it rises to 1.9%. The average for the three sites is 1.4% of the debitage categorized as retouched or utilized.

Both flakes categorized as retouched and those categorized as utilized have been included so far. This is in recognition of the fact that distinguishing between items of these categories can be problematic. The fact that in the initial analysis of Sites EkPu-8 (Dawe and Ronaghan 1998) and 1626R (Darwent 1995; Sandgathe 1997) there were indicated to be retouched flakes and utilized flakes present, but none categorized as both suggests that the retouched flakes either did not have identifiable use-wear or were not examined for such because the retouch was considered to be evidence enough that the flake had been used as a tool. In the initial analysis of Site 243R (Hudecek-Cuffe 1998 - report in progress) flakes with retouch were examined for visible use-wear and so no distinction was made between the two within the category of utilized flakes. Retouched flakes with visible edge-damage interpreted as use-wear were categorized as Utilized flakes.

If just those categorized as utilized are considered, the average percentage for the three sites is approximately 1.2%. This leaves more than 98% of the assemblages that presumably might have been produced as unmodified flake tools, but were not identified as utilized. However, as some bifaces of clastic sedimentary materials were being produced at the three sites, the percentage of flakes in the assemblages that were specifically produced as unmodified flake tools will undoubtedly be lower than 98%.

8.2 Microscopic Examination

Both the experimental data and the subsequent microscopic examination of the archaeological samples can provide us with some insight into the potential frequencies of utilized flakes in these sites.

Of the flakes used in the experiments for this thesis, it is suggested that only those with wear categorized as Easily Discernible, and possibly those with Some Discernible Wear (as observed without visual aid), would be categorized as utilized or retouched by an analyst if they were in an archaeological assemblage. Given this assumption, the experimental results (Table 6.3) indicate that 17 percent of the experimental assemblage would have been identified as utilized.

Under 20X magnification, edge-damage that was categorized as extensive or substantial is suggested to be a level of edge-damage that would be relatively easy to identifiable as use-wear. Edge-damage categorized as minor is suggested here to be likely identifiable as use-wear by an analyst with some (though not necessarily extensive) previous experience with this system of categorization. If this is the case then 27.8 % of the experimental assemblage would be easily identifiable and 57.4 % would be likely identifiable as utilized under comparable magnification.

8.3 General Task Visibility

The experimental data from Part B does provide an indicator of visibility, or lack thereof, of general task types.

Of the ten experimental tasks that involved scraping task materials classified as hard (antler and wood), seven would have been recognized as utilized without visual aid and the remaining three might have gone unrecognized. All ten exhibited minor edge-damage or greater under the microscope. Nine of the ten (90%) had substantial damage. The one flake with minor wear had been used to scrape wood for one minute. This suggests that few, if any, flakes used in scraping hard materials would go unrecognized in an assemblage, under low-powered magnification.

Of the eight flakes used to cut hard materials all acquired minor damage or greater. Half of these had minor wear and the other half had substantial wear. Only two of the flakes used to cut antler had damage that would have been recognizable as such without visual aid. Therefore, it seems more than likely that the majority of those flakes identified as utilized in the initial analysis of the three site assemblages were tools used for scraping hard materials.

Of the six flakes applied to scraping soft materials (fresh hide) in the experiments, none had edge-damage recognizable without visual aid. Under the microscope three out of six incurred minor damage. Flakes applied to scraping soft materials are not identifiable without visual aid but have a 50% chance of being recognized under low-power.

Eighteen flakes were used to cut soft materials in Part B. Only three of these (16.7%) acquired even minor wear and all three were used for cutting either meat or fresh hide. In Part A all nine flakes were used to cut soft materials that included meat and fresh hide. Seven of these nine acquired minor wear while the remaining two had negligible wear. None of the flakes used to cut soft materials in either Part A or B would have been recognized as utilized without magnification and even with magnification only ten out of 27 (37%) would have been recognized with low-power magnification and all ten were used to cut meat or fresh hide. Of the six flakes used to cut carrots, none acquired any damage visible with low-power magnification.

Twelve flakes were used to cut medium materials (raffia and dry hide). None of these acquired damage that was recognizable as use-wear without magnification. With magnification seven (58.3%) exhibited minor or substantial damage.

These numbers suggest that flakes used in tasks that involve scraping hard materials will likely be identifiable in an archaeological assemblage with or without magnification. However, the majority of flakes applied to medium or soft materials, whether for cutting or scraping, will go unrecognized without visual aid. With low-power magnification, approximately 40% of those flakes used in butchering tasks and approximately 60% of those flakes applied to cutting medium materials might be identifiable. Possibly none of the flakes used to cut tubers will be identifiable.

Research carried out regarding unmodified flake tools in assemblages from the High Prairie region of Central Utah failed to associate use-wear detected on the flakes with tuber processing (Brisland 1992). Experimentally produced flake tools exhibited edge-wear that could not be confidently related to camas processing. However, the raw materials from which the tools in this study were produced were mainly obsidian and chert with a minor component of basalt and so the formation of damage will not be directly comparable to that produced and observed here.

As the descriptors employed in the experimental part of the thesis and in the analysis of the archaeological samples just indicate degrees of damage and are not associated with specific types of damage, no direct correlations can be made about actual frequencies of tasks represented by the edge-damage observed in the archaeological samples. For example: there is no way to determine, based on these descriptors, whether those archaeological flakes with edge-damage described as minor, acquired it through scraping or cutting and whether the task materials were hard, medium or soft.

In Table 8.5 we can see the relative occurrence of the different degrees of edge-damage observed in the experimental and archaeological assemblages. It is tempting to compare straight across the relative frequencies of the types of edge-damage observed on the experimental flakes to the relative frequencies observed on the archaeological samples, as is laid out in Table 8.5. To suggest that this comparison was legitimate would be to suggest that the types of tasks and relative quantities of different tasks selected for inclusion in the experiments was the same as those that had been carried out at the three sample sites. This obviously would be an amazing coincidence if it were true and, of course, there is no way to know at this point.

Table 8.5 Comparison of frequencies and percent frequencies of levels of damage, observable with 20X magnification, in the experimental and archaeological samples.

degree of edge-damage	Experiment Samples		Early Prehistoric Sample		Mid Prehistoric Sample		Total Arch. Samples	
	Freq.	% of Total	Freq.	% of Total	Freq.	% of Total	Freq.	% of Total
NOW	19	35.2	33	33.0	38	38.4	71	35.7
Minor	20	37.0	21	21.0	19	19.2	40	20.1
Substantial	15	27.8	46	46.0	42	42.4	88	44.2
Total	54	100.0	100	100.0	99	100.0	199	100.0

What the comparison of the two sets of data does show is that analysis of the archaeological samples of both periods supports the indication in the experimental data, that the majority of unmodified flakes that were employed as tools in the Early and Middle Prehistoric components of the Eastern Slopes sites studied here, are not being detected. Furthermore, examination with low-powered microscopy increases the level of detection substantially. In the experimental assemblage the percentage of detected utilized flakes increases from 16.6% without visual aid to 57.4% with low-powered magnification. In the archaeological assemblages the percentage of initially identified utilized flakes, of clastic sedimentary items > 10 mm in maximum dimension, was approximately 1.2% and the percentage of the archaeological samples that was identified as utilized was 61.9%.

8.4 Flake Size as Tool Selection Criteria

Both the ethnographic information and the results of the examination of the archaeological samples indicate that size is, not surprisingly, an important criterion in the selection of flakes as unmodified tools. The ethnographic accounts from both New Guinea (White 1968) and Brazil (Miller 1979) suggest that the comfort of handling was important in the selection criteria to the individuals using the tools.

Some items of debitage are simply too small to be usable as hand-held flake tools. For purposes here the size cutoff is arbitrarily drawn at ≤ 10 millimeters between the potentially usable and the obviously unusable. The actual practical point of cutoff between usable and unusable flakes may be closer to 15 millimeters, but some flakes less than 15 mm in maximum dimension with indications of retouch and utilizations have been identified in the three archaeological assemblages. The results of the analysis of the archaeological samples support the general expectation that, edge morphology aside, the larger the flake the more likely it is to be employed as a tool. However, the Early Prehistoric data seem to suggest that, while the probability of a flake >50 mm in maximum dimension being used is between 80% and 100%, the probability of utilization for all flakes < 50 mm does not decrease along with decreases in size. For example: a flake that is 20 mm in maximum dimension has approximately the same probability of being used as a flake that is 40 mm or a flake that is 10 mm. For all the flakes > 10 mm and < 50 mm the probability of utilization remains between 65 and 75%.

For the Middle Prehistoric assemblage the same pattern appears, although the numbers are somewhat different. For this assemblage the probability of use for flakes > 50 mm is 75% to 100% and the probability of use for flakes > 10 mm and < 50 mm is between 60% and 70%.

Perhaps this is a reflection of prehistoric perception of optimal tool size. Given the choice, an individual will likely prefer to use a flake 50 mm or larger, but if suitable flakes this size are not available, size loses some of its importance in the selection criteria. However, if this were the case, it would be expected that greater effort would be expended during the reduction process to produce more of these larger flakes.

One trend that was consistent through the whole assemblage was that, of all the flakes with some level of edge-damage, the larger the flake the greater the liklihood that it will have more than just minor damage. This would be consistent with the suggestion that once an individual has gone through the effort of producing an assemblage of unmodified flake tools or perhaps gathering together a collection of potentially usable flakes from some other source (e.g. an older assemblage already laying around from some previous reduction activities as per Gould's [1980: 124] observations), they will tend to employ the "more suitable" flakes for a relatively longer duration, compared to flakes that are suitable but not as good, or for multiple tasks. In this case it is suggested that, other potential factors aside, the larger the flake the "more suitable" it is for whatever the task because it is more comfortable to hold and allows the application of more pressure.

8.5 Factors Affecting Use-Wear Visibility

While the suggestion here is that relative strength of raw material plays an important part in the nature and visibility of use-wear, other potentially obscuring factors have been suggested. One of these is the possibility that during the butchering of an animal the fatty residues of the animal coat the tool edge and reduce the degree of contact and subsequent wear (Brose 1975). The part played by fatty residues may well be directly tied to raw material. Brose reported that tools of materials with more granular surfaces tended to collect fat on their surface more readily which resulted in their exhibiting a loss of function sooner than smoother surfaced tools. Smoother surfaced tools then tended to be used for a longer period of time resulting in the acquisition of greater wear (Brose 1975: 93). Brose was comparing "granular" flints and cherts to "less granular" obsidian (his terminology in quotation marks). The difference in granularity between silicified clastic materials and chert, flint, and obsidian is likely much greater than the degree of difference among the latter three.

Brose's suggestion could be a factor in the formation and exhibition of use-wear in the relatively granular surfaced tools of Eastern Slopes assemblages and could specifically be a factor in the extremely low visibility of edge-damage on the experimental tools used for cutting meat. Brose, however, was defining degrees of edge-damage specifically on microscopic striations that he apparently expected on tool edges used for butchering. The simple fact that some tools have greater surface relief could interfere with the formation of continuous striations that might be more readily observable. If microdebitage is considered to be the main source of striations on tool edges used to cut fresh meat, any relative decrease in the brittleness of the tool material might result in fewer striations being formed. The introduction of dirt into the task material could certainly potentially cause striations, but while this could happen, it would seem unreasonable to consider it typical of prehistoric conditions.

In the experiments conducted here, it was noted that the adherence of hair and tissue to the tool edges inhibited their performance and the tool edges had to be manually cleaned occasionally. The main factor in the accumulation of detritus on the tool edges was the regularity of the edge. An edge that had a less regular plan view tended to accumulate material more quickly and in greater quantities than edges that were more regular in morphology. However, both granularity of raw material and a certain degree of irregularity to tool edges also tended to make them more effective for cutting as they provided a serrating quality to the edges. Based on the experiments carried out here I could understand Frison's (1989: 777), assertion that the graininess of certain (quartzite) flake tools he was using for butchering tasks resulted in their retaining their effectiveness longer than tools of less grainy materials such as chert or obsidian. Contrary to Brose's suggestion (1975: 93) this should result in tools of more granular lithology being employed longer than smoother surfaced tools. This could depend, however, on whether the person doing the butchering (or other tasks) is more inclined to replace a tool, the edge of which has become too clogged to perform properly, or to clear the edge and carry on.

Chaper 9.0 Theoretical Discussion

9.1 "Tools" vs. "Waste Flakes": the Peripheralization of Debitage

It is argued here that the range of imagined or suggested scenarios of behaviour that could be associated with stone tool production and use has been limited by traditional categorizations of stone items. In spite of the fact that the analysis of debitage has become a major field of study in archaeology, to many archaeologists debitage is still mainly regarded, consciously or not, as the by-product of other intended products rather than an intended product itself (see Gero 1991, 164-66, for a similar discussion). Debitage tends to be seen in contrast to tools, the latter being the intended result with the former being the unavoidable waste product. Both categories, tools and debitage, are laden with implicit meaning. Items categorized as tools are conceptualized as useful and perhaps necessary or indispensable; they typically have well defined morphological form that is presumably often the result of an individual's or group's conscious preconceptions and specifically directed behaviour. They are typically retained in a person's possession once they are manufactured and often become aspects of a culture's material identity. In fact, in many cases these stone tools become the sole symbol, to many archaeologists, of a past culture (e.g., Clovis projectile points). Debitage, on the other hand, is relegated to the category of waste, and while it is recognized that this waste may well contain valuable information about the culture that produced it, it is seen explicitly as a discarded aspect of that culture. Even though the finished formal tool and the debitage may be recovered in direct association, because the debitage is seen as discarded, it has, from the point of view of many archaeologists, become a peripheral component of the material record. Because of this conceptualization and contrasting categorization of debitage it is not surprising that archaeologists (with perhaps the exception of some lithic specialists) have a tendency to exclude flakes, unless they have obvious retouch or use-wear (and even then they may not be given more than a cursory inspection and have limited impact on interpretations), from more rigorous examination beyond simply weighing and measuring dimensions. Crabtree (1977: 38-39) alludes to this tendency in his identification of questions that arise from initial experiments in use-wear on obtuse angled edges.

> A second [question] deals with the separation of "tools" themselves from the lithic debris or debitage, which is a natural byproduct of their manufacture.
> (quotation marks in original)

Parry and Kelly (1987: 287), in their description of New Guinean stone tool manufacture, note that among those individuals actually doing the flaking:

> . . . no explicit distinction is made between "tools" and "waste". Every piece is regarded as a potential tool. (quotation marks in original)

Parry and Kelly's (1987) description refers expressly to expedient core technology and so the knapper's mind-set here is not directly analogous to that of someone practicing specifically bifacial reduction. A clearly defined distinction between core reduction and bifacial reduction is, however, a theoretical construct of archaeology. It is easily plausible for situations to arise in which both are practised in concert. When one thinks of everyday-type scenarios it is not difficult to imagine situations in which the debitage resulting from one person's formal tool production is taken advantage of by another person for a task at hand. In fact Gould (1980: 124 & 131) provides an ethnographic account of exactly this type of occurrence. There is also the established concept of using large bifaces as cores (as discussed by Kelly and Todd 1988) and ethnographic examples of this application of bifacial technology in the production of expedient flake tools is provided by Binford (1979: 262). In this case the assumption is that, even though the reduction is bifacial in nature, the flakes are the intended production concern. The presence of bifacial reduction flakes in an assemblage is often used as an indicator of biface production rather than core reduction/expedient flake production. This may be justified in situations where the debitage assemblage is comprised mainly of small pressure flaking debris. When the bifacial debitage is comprised of medium to large flakes, however, it becomes more tenuous to presume that it derives from one narrowly directed task. In situations where bifacial core technology is practiced and the intended result is solely expedient flakes one might expect to find exhausted bifacial cores which should act as a red flag to alert the researcher to look for utilized flakes. However, if bifacial production and bifacial core reduction are one and the same there may be no obvious clues left to intimate this. This latter scenario would reflect the type of technological organization hypothesized by Kelly and Todd (1988) for Early Prehistoric, highly mobile groups. This technological organization would involve the production and retention of bifaces, which could be used both as tools themselves and as cores from which expedient flakes are struck. The implication is that the assumption that an assemblage dominated by bifacial reduction flakes is the result of just formal tool production fails to recognize a greater range of potential scenarios of behaviour which could greatly modify our interpretations and understanding of adaptations.

9.1.1 Expedient Tools

Archaeologists recognize the ethnographic and prehistoric practice of making use of unmodified flakes of stone as expedient, disposable tools. Certain researchers have focused much of their studies on the experimental replication of distinctive wear patterns on flakes (Hayden and Kamminga 1979; Keeley 1974; Semenov 1964; Tringham et al. 1974; Vaughan 1985; etc.) and several others have focused their attention on the theoretical issues behind the use of expedient verses formal tools

(Bamforth 1986; Binford 1979; Parry and Kelly 1987; Shott 1989a, 1989b). However, when it comes to the practical analysis of actual site assemblages there is, apparently, often a reluctance to acknowledge the potential presence of these tools in an assemblage of debitage unless the evidence of their use is easily recognized with the naked eye, i.e., macroscopic retouch (Bamforth 1985; Gero 1991; Young and Bamforth 1990). Obviously there are some exceptions to this tendency (e.g., Bamforth 1985; Le Blanc 1984). This reluctance to acknowledge, or at least attempt to detect, the potential presence of utilized flakes is due in part to two different factors. The first is that there is a pre-occupation with, and heavy focus on, formal tools at the expense of expedient tools. The second factor is that the detection of any less-than-obvious use-wear necessarily requires the application of microscopic analysis which adds to the cost of research through added lab time and equipment.

Research has been conducted comparing the relative effectiveness of an unmodified flake verses a bifacially worked tool (e.g., Walker 1978). Bifaces tend to excel in tasks that require the application of greater pressure and those that require the cutting of harder materials like wood or bone. One of the advantages of biface knives is that they tend to be larger than a typical flake and so afford a better and more comfortable hand-hold and their size also allows them to be more readily hafted. They also tend to be stronger as a whole and their cutting edge tends to be somewhat serrated, more durable and dulls less quickly. Unmodified flakes on the other hand have the advantage of being much sharper then the edge of a biface knife. They also represent far less labour input and so are more easily discarded and replaced as they become less than effective (Parry and Kelly 1987; Walker 1978). In their application to the cutting of softer materials, such as hide or meat, expedient flakes do not necessarily lose their effectiveness quickly (Frison 1989). Other considerations aside, for the simple act of cutting, an unmodified flake is more effective than the edge of a biface when applied to meat or hides. Unfortunately, it is the softer nature of these task materials that results in a lack of noticeable wear on the tool edge and the resulting difficulty in detecting a flake utilized for these purposes in a larger assemblage of debitage.

9.2 Lithic Technology and its Relation to Mobility and Settlement Patterns

The failure to detect utilized flakes in a site assemblage has much further reaching implications than is apparently recognized (Young and Bamforth 1990). There is little question of the importance of understanding the technological organization of prehistoric groups if we are to better understand their overall adaptive strategies. The specifics of a group's stone tool technological organization are seen to be directly related to the level of mobility and settlement patterns practiced by that group (e.g., Bamforth 1985 and 1986; Binford 1979; Henry 1989; Kelly 1983; Kelly and Todd 1988; Kuhn 1994; Shott 1986). How a group has opted to exploit the lithic resources of a region provides insight into how they exploited the resources of that region as a whole. Currently, there seems to be a tendency in some circles (specifically the Plains) to perpetuate the idea that the formal tools associated with prehistoric cultures represent the backbone of that culture's technology or at least the lithic component of that technology. In view of the level of effort put into attempting to detect the presence of utilized flakes the status accorded formal tools seems unwarranted.

It seems likely that, based on the differential size distributions of specific raw material types in the three archaeological assemblages studied here and the results of the microscopic examination of the flake samples, that much of the reduction of clastic sedimentary materials at these sites was directed towards the production of flakes for use as unmodified tools. This may not seem, to some, to be a particularly contentious point that requires much support. The idea that prehistoric people regularly employed unmodified flake tools is regularly expressed in the literature (e.g., Bamforth 1985;

Frison and Bradley 1980). However, this idea is very rarely explicitly discussed and tends to be dealt with in an off-hand and indirect manner. In fact, there is very little literature directly addressing the issue of unmodified flake tool technology (notable exceptions include Bamforth 1985; Gero 1991; Young and Bamforth 1990). The implication is that most archaeologists/ anthropologists, while perhaps assuming the use of unmodified flake tools was common, do not consider it an important enough aspect of prehistoric behaviour to warrant any particular attention (see Gero 1991 for a further discussion of this tendency). Analysis of assemblages should go beyond simply noting the presence of macroscopically retouched and utilized flakes and start to try to determine actual frequencies (Young and Bamforth 1990). It is asserted here that the relative portions of a group's lithic technology that are comprised of formal tools verses unmodified flake tools may have significant relevance to and may be closely associated with, among other things, levels of mobility and settlement patterns .

9.2.1 Mobility

This restricted view of stone tools is particularly evident in Early Prehistoric/Paleoindian research in North America in which bifaces and bifacial technology is suggested to be especially significant (e.g. Kelly 1988). This may be theoretically justified if all Early Prehistoric/Paleoindian groups consistently maintained levels of mobility high enough to warrant the adoption of bifacial technology, and its apparent advantages to frequent and long distant moves, at the expense of other lithic technological adaptations (Kuhn 1994; Henry 1989; Kelly 1988; Kelly and Todd 1988; Bamforth 1986; Kelly 1983; Shott 1986).

That Early Prehistoric adaptations involved high mobility levels is argued for on the basis of several factors: (1) The probable heavy reliance of these groups on big game resources which tend to require a group to maintain certain levels of mobility to efficiently exploit the game (e.g. Kelly and Todd 1988). (2) The observation that

Early Prehistoric groups, who apparently had a strong preference for high quality lithic raw materials, acquired and transported raw materials over great distances (e.g., Kelly 1983; Kelly and Todd 1988; Kuhn 1994; Meltzer 1985; Ricklis and Cox 1993; Tankersley 1991). It has even been suggested that the frequency of exotic lithic materials is a measure of the degree of mobility of a group (Meltzer 1985). (3) The distribution, particularly in the Early Prehistoric/Paleoindian Period, of stylistically identical or similar artifacts, such as the Clovis point, over huge areas of the continent also tends to support the high mobility scenario (Meltzer 1985: 2-3). (4) The nature of the vast majority of Early Prehistoric sites, being limited in size and frequency of reuse, tends to support the idea of frequent moves and short stays (Kelly and Todd 1988: 236-237).

The majority of these arguments hold much weight and there seems little doubt that for the majority of Early Prehistoric/Paleoindian groups in most areas of the continent high levels of mobility were an important aspect of their lifeways. However, the evidence generally associated with the arguments for high Early Prehistoric/Paleoindian mobility is not found over the whole continent. In some regions high quality "exotic" raw materials are not the focus of lithic technologies (Meltzer 1985) and the Eastern Slopes of the Alberta Rockies is an example of an area where exotic lithic materials comprised little if any of the materials exploited in the Early Prehistoric Period. In fact, in this region this patterns appears to continue into the Middle Prehistoric Period.

9.3 Lithic Technology and Early Prehistoric Eastern Slopes Adaptations

Several different factors come together in the Eastern Slopes that could result in a difference in lifeway patterns here, such as resourse distribution and raw material flakability, and several lines of evidence suggest that this might have been so.

9.3.1 Resource Distribution

There are several theoretical factors that underlay the evidence for high mobility and dictate or influence specific aspects of hunter-gather adaptations. These include factors such as population density and the nature of inter-group interaction. However, the level of mobility of a group probably depends on the nature of the resources they exploit more than any other factor (e.g., Andrefsky 1994; Bettinger 1991; Binford 1980 and 1979; Gramley 1980; Kelly 1983; Kelly and Todd 1988; Shott 1986). Temporal and spatial incongruities of necessary resources typically make residential movement an unavoidable necessity. The frequency and distance of these moves will depend on the degree of resource incongruity (Binford 1980). In many regions and environments only food production can completely overcome this. Food preservation technology and storage techniques can help to even out resource availability but rarely completely overcome the need for mobility of some level (Binford 1980 and 1979; Kelly 1983). There are notable exceptions in which specific naturally occurring resources allow the adoption of a mainly sedentary lifeway. The Northwest Coast of North America is one such example in which natural resources, in this case mainly salmon, allowed highly sedentary and complex societies to develop.

While paleoenvironmental reconstruction studies in the Eastern Slopes have increased in the last decade or more (Beaudoin 1993: 92) (e.g., Beaudoin 1986; Beaudoin and King 1990; Luckman and Kearney 1986), based on the dearth of available literature, little research has been conducted on reconstructing prehistoric fauna patterns for the region. While faunal remains recovered from archaeological sites provide some information, reconstructing an accurate picture of Early Holocene fauna is hampered by two factors; the acidic nature of the soil of much of the Eastern Slopes and the high energy nature of the geologic processes in mountainous regions (more rapid movement of larger volumes of sediments), which both prevent good preservation. Currently most of the Alberta Rockies are covered by boreal forest with limited patches of parkland and open grassland in valley bottoms. Faunal composition and distribution in most regions of the Rockies is currently similar to that of the boreal forest region that covers the northern half of the province. The boreal forest environment, unlike the open grassland of the Plains, is comprised of a much lower biomass and human exploited resources tend to be fewer and further between. The Boreal Forest tends to only allow very low population density, comprised of small groups separated by long distances (Ives 1990). Unlike the Boreal Forest, however, the larger patches of open grassland in the Eastern Slopes, represented by the Ya-Ha-Tinda Ranch and the Athabasca Valley in Jasper National Park sustain large herds of elk (Morgantini 1995; Ronaghan 1993).

Pollen records from some of the upper passes in the front ranges indicate that through much of the early Holocene the Alberta Rockies were dominated by grasses and sages (Beaudoin 1986; Beaudoin and King 1990). It is in this type of environment that current populations of elk are thriving (Morgantini 1995) and, in the past, this type of environment may well have encouraged populations of bison to remain year round rather than simply use the area as a sheltered wintering habitat. Large game animals, while not nearly as abundant as on the Plains to the east, may have been available throughout the Eastern Slopes year round. The high relief topography of the mountain regions may have also made the hunting and acquisition of large game easier, for small groups of people, than that experienced on the open plains. In the Plains animals would be more difficult to approach and to limit the movement of, due to the presence of fewer natural landforms to serve as cover or barriers. This suggested scenario would have meant decreased levels of temporal and spatial incongruencies compared to those encountered by big game hunters on the Plains. It certainly could not be suggested that food resources were available here to the extent observed on the Northwest Coast. It is possible, however, that access to and acquisition of food resources in the Alberta Rockies allowed a somewhat lower level of mobility than is suggested for most Early Prehistoric groups.

9.3.2 Technological Organization

It has been argued specifically by some that bifacial technology is the lithic technology most compatible with high mobility adaptations (Kelly and Todd 1988; Kelly 1988 and Parry and Kelly 1987). The argument is that technological organization of highly mobile adaptations must overcome both the problem of lithic material availability and weight-carrying constraints (Andrefsky 1994; Feder 1981; Gould and Saggers 1985; Wiant and Hassan 1985). Bifacial technology addresses both problems. Bifaces tend to be highly versatile and can be used for a wide variety of tasks with little or no modification other than occasional resharpening so that the raw material of the tool can be economized. A single tool will tend to last, reducing the worry of whether new ones will be required before a group encounters a new raw material source. The versatility also means few varieties of tools have to be carried. In situations where unmodified flake tools might be necessary, they can easily be removed from a biface with no accompanying waste. Because a biface is formed prior to movement from the raw material source an individual never carries the weight of unusable raw material around as, for example, would be the case if an individual carried an amorphous core around from which tools and unavoidable waste were struck when needed.

It has also been specifically argued by some that the production of unmodified flake tools from a core for expedient application is a technology most compatible with more sedentary lifeways (Parry and Kelly 1987). One disadvantage of a biface is that it requires a certain investment of labour and is carried around even when not specifically in use. For an individual who is not constantly travelling about his or her environment and is always in the vicinity of a source of raw material this is unnecessary. If an individual(s) is going to be in a specific location for any length of time it makes more sense to either select a location close to a lithic material source if other dictates permit, or specifically go out and collect a large quantity of the raw material from a distant location and bring it to this location for use there. Then the individual(s) need only remove one or more flakes, as required, from cores of the raw material and discard them when the task at hand is finished. If a tool of specific design, such as a projectile point, is required it can be manufactured when it is required. The versatility then lies in the availability of the raw material rather than in tool design. In this situation, carrying constraints are not an issue with raw materials.

In both these scenarios one of the most important factors in the organization of technology is the availability of the raw material. The organization of the two technologies is in large part a response to the relative availability of the raw material in each scenario. In the case of high mobility, availability to raw materials is low while in the more sedentary situation availability of raw material can be essentially unrestricted.

These respective scenarios and their suggested organizational responses are both based on the underlying assumption that raw material sources generally occur as isolated locations widely distributed over the landscape (Andrefsky 1994; Gramley 1980). In most regions this may well be an accurate description. The Eastern Slopes, as has been discussed above, does not fit this description. Raw materials, of suitable qualities, are readily available almost anywhere in this region. Thus raw material availability, and any need for economization, is effectively removed as a constraint on technological organization in the Eastern Slopes regardless of the level of mobility.

The respective advantages of formal vs. expedient tools have so far been associated with mobile hunter-gatherers and sedentary groups respectively. Parry and Kelly (1987), in their argument for a direct association between expedient core technology and more sedentary lifeways, did not exclude hunter-gatherers from their examples of more sedentary groups, but they did focus more heavily on ethnographic and prehistoric groups in which some agriculture and permanent villages were the typical lifeway.

The archaeological record in the Eastern Slopes precludes any suggestion of sedentism or villages (Ronaghan 1986). Any discussion of levels of mobility of prehistoric Eastern Slopes groups is a discussion of degrees of difference in hunter-gatherer group mobility and not a discussion of mobility verses sedentism.

9.3.3 Collectors vs. Foragers

Binford (1980) provides a very useful framework, based on ethnographic data, for the theoretical categorization of varying adaptations of hunter-gatherer groups that directly addresses levels of mobility and settlement patterns. The two general categories are collectors and foragers. These each represent one extreme in a gradation of adaptation forms. They can be crudely distinguished by the general tendency for collectors to move resources to people and foragers to move people to resources.

Collectors tend to have less frequent residential moves from base camp to base camp. From each base camp small special task groups are sent out to exploit specific resources and return with them to the base camp. Their movement over the landscape over time can be envisioned as a line connecting a series of large dots, representing base camps, from out of which extend short radiating lines connecting each large dot to several smaller dots, representing special task/resource extraction locations. This pattern of resource exploitation is referred to as **logistical organization** because it revolves around specially organized logistical task groups which go out on forays which may last several days (Binford 1980). Collectors also practice the storage of food in order to address problems of resource incongruity.

Foragers, at the other end of the scale, move their residential camp more frequently. Instead of special task groups sent out from the main group to exploit resources, the whole group **maps onto** specific resources. Small groups may still be sent out on forays, but, unlike collectors, these are typically short in distance and duration. Foragers always return to the base camp each evening. Forager movements over time can be envisioned as an irregular circle around a group's territory connecting many dots which represent each mapping-on of the residential camp to resources in that location. Foragers practice limited food storage. They overcome temporal and spatial incongruities of resources by moving to resources when they are available and/or required (Binford 1979). Foraging adaptations are therefore more common in environments where resource distribution (temporal and spatial) is more homogeneous. As discussed above this may, arguably, have been the situation in the Early Prehistoric period in the Eastern Slopes.

Binford suggests that among collectors, such as the Nunamiut Eskimos who he worked with, curated tools will predominate (Binford 1979). He suggests that, because among collectors the exploitation of resources occurs as more or less preplanned logistically organized extraction forays, specific task oriented tools can be prepared before-hand. Collectors would be more inclined to have a greater variety of tools each with specific uses rather than a limited number of more versatile tools.

As Binford specifically associates tool curation with collectors, it is implied that he associates expedient tool technology with forager lifeways (Bamforth 1986: 40). However, because small forager groups do not set out to exploit specific resources they would tend to require more versatile tool kits. Their tool kits must be adaptable for use in whatever situation arises. This would seem to better resemble the conditions that are argued, by some, to favour the use of formal bifacial technology (e.g., Kelly 1988).

The direct association, that has been suggested (e.g., Kelly 1988; Parry and Kelly 1987), between simple level of mobility and expediency vs. curation of tools is called into question by the ethnographic data. Binford (1979: 263) describes personal gear among the Nunamiut Eskimo men which included simple flakes carried in pouches. This personal gear would be carried with a man when he went out with small groups on trips into the field. Individuals apparently removed the flakes from large cores prior to setting out on a trip. This example of individuals carrying unmodified flake tools on forays contradicts Binford's own claim that personal gear was heavily curated (1979: 263). These flakes would appear, however, to be the exception to the rule, for much time and effort is spent ensuring that the majority of the tools included in personal gear are in perfect condition before being taken out into the field (Binford 1979: 262). In the case of the Nunamiut it may be that in certain cases flake tools are the best suited tool, in their unmodified form, to a certain task and so their inclusion in personal gear prior to an outing may satisfy Binford's idea of specialized tools. However, the problem remains that, since little labour went into the making of these specific tools, they may be far more likely to be discarded at the place they were used than the rest of the tools in the collection of personal gear. Binford also indicates that at times the Nunamiut men carry small cores into the field from which flakes are struck for use in butchering tasks if they happen to arise unexpectedly (1979: 262). These flakes would be considered, in these circumstances, **situational gear**. As mentioned above (Chapter 2, section 2.4) Binford and his informants had come across a site where such tools had been used and discarded. This demonstrates two different specific uses of unmodified flakes which theoretically would be indistinguishable from each other in the archaeological record. In the one case the flake tools are taken into the field after first being produced at a base camp where the evidence for the reduction activities would remain and in the other case the tools are produced in the field at the site of a special task, but again only the flakes themselves would be left behind. Both are apparently the archaeological remains of curated technologies, but in the form of unmodified flake tools.

Bifacial reduction flakes with evidence of utilization recovered from archaeological sites (e.g., Le Blanc 1984: 119; Hudecek-Cuffe 1998 - report in progress) may be examples of either curated personal gear or flakes that were already at the site from previous occupations and were made use of because of their convenience (site furniture? - as per Binford 1979). Ethnographic examples of the use of flakes lying around from previous activities, as mentioned above, has been provided by Gould (1980: 124, 131).

Binford, however, obviously considers the simple flakes carried in the individual's personal gear as curated because he indicates that the use of expedient tools depends on whether the tasks at hand are situational or not. If the task requires situational gear, which is viewed in contrast to personal gear or site furniture (items that remain at a site for later use at that location), little time or effort goes into its manufacture (1979: 265-66). This means that the relative occurrence of unmodified flake tools at any one site/occupation will depend on the nature of the occupation. In other words, was it a camp site of relatively long duration in which tasks more substantial than situational may have been carried out, or was it an occupation of limited duration and limited variability of tasks in which case most or all of the tasks may have been situational and were not addressed with specialized tools?

More thorough methods of detection of utilized flakes, resulting in a more accurate understanding of the relative occurrence of utilized flakes to non-utilized flakes in a site assemblage, can potentially serve as immediate evidence of site activities. If few or no utilized flakes are noted in a site assemblage then, regardless of the type of reduction suggested by other lines of evidence (e.g., core reduction-flake production based on the presence of cores, relatively large debitage, and a lack of bifacial reduction flakes), it would seem unlikely that the reduction was carried out to produce expedient flakes. The lack of utilized flakes may serve as one line of evidence to suggest an alternate purpose for the reduction activities, such as blank production. The problem does arise, however, that the intention might have been to produce unmodified flake tools, but these were removed for use elsewhere (e.g., Binford 1979: 263). If, on the other hand, a large portion of an assemblage is comprised of utilized flakes, this would tend to indicate that, regardless of reduction type, the assemblage was specifically produced for this purpose. It would seem unlikely that incidental use of flakes lying around from previous reduction episodes (e.g., Gould 1980: 124) would result in large portions of utilized flakes in assemblages.

In an environment where potentially suitable materials are always within easy reach (unlike the Nunamiut situation - Binford 1979) expedient tools may take on roles that in other environments were necessarily addressed with tools (likely curated) that were specifically designed for the purpose. If tools had to be carried (personal gear) because of raw material availability constraints, weight constraints will dictate that that the tools be pre-manufactured (excess weight removed) and therefore their design predetermined to some degree, making them formal tools even though they may be suitable for a variety of tasks. Binford suggests (1979: 269) that significant differences will be seen between base camps and special purpose sites in the nature of their debitage. One would expect to find evidence of the manufacture, maintenance and discard of personal gear (i.e. formal tools) at base camps and expedient tools at special purpose sites. This may not be the case in Eastern Slopes sites where significant mixing might occur due to a greater emphasis on expedient tools due to raw material availability.

The ethnographic data indicate that, among hunter-gatherers, no one type of lifeway will *necessarily* require people to adopt a specific technology (e.g., Binford

1979; Gallagher 1977; Gould 1980; Gould and Saggers 1985; Kelly 1983; Parry and Kelly 1987). Both higher and lower mobility groups employ unmodified flake or expedient tool technology to one degree or another. However, there do appear to be tendencies for specific adaptations to employ specific technologies more readily. More ethnographic and archaeological work (both theoretical and practical) needs to be carried out to provide us with a better understanding of the relationship between technological organization and other aspects of hunter-gatherer adaptations. It must also be kept in mind that the lithic components of prehistoric technologies likely made up only a small percentage of entire tool kits. The portions of the tool kits recovered by archaeologists cannot be discussed in isolation from the consideration of those portions not recovered.

Mainly this illustrates the need for caution in directly associating specific technologies with other aspects of adaptations, such as settlement patterns. Obviously the nature of technological organization is more complex than simply a response to level of mobility. However, given the known and possible nature of resources, such as lithic materials and large mammals, it is possible that the nature and interaction of settlement patterns and lithic technology in the Eastern Slopes in the Early Prehistoric period was markedly different than is typically envisioned for much of the continent during that time period. Understanding the nature of prehistoric adaptations here necessarily requires a more indepth understanding of the *whole* of the tool kits represented by the archaeological record.

Chapter 10 Conclusions

In Early Prehistoric/Paleoindian studies, archaeologists heavily stress the formal bifacial tool aspect of their lithic technologies (Bamforth 1985: 252). Large, well made bifacial projectile points are the hall mark of this period and, not surprisingly attract much attention from the archaeologist and interested lay-people as well. Arguments have, in fact, been forwarded that Paleo-Indian adaptations relied almost entirely on bifacial technology because of its versatility and ease of portability (Kelly 1988; Kelly and Todd 1988). This line of thought is based on the idea that access to raw materials is likely one of the most important factors influencing the technological organization of mobile peoples (e.g., Andrefsky 1994; Bamforth 1986 and 1985; Binford 1979; Kelly 1988 and 1983; Kelly and Todd 1988; Kuhn 1994; Parry and Kelly 1987; Shott 1986; Wiant and Hassan 1985). This argument holds much weight and, in fact, is difficult to dispute when it is applied to areas of the continent where raw material sources tend to occur in discrete, incongruous sources across the landscape.

However, in areas where raw material access and availability are essentially removed as important factors in organization of technology the advantages of bifacial technology, with respect to mobility, disappear. This may be the case in the Eastern Slopes of Alberta where usable, though not necessarily high quality raw materials are essentially ubiquitous. These silicified clastic sedimentary materials would not be considered high quality by most archaeologists because they do not flake as readily as the more commonly known lithic materials such as cherts, flints and obsidian. They do tend to be harder and less brittle than these other materials (Gryba personal communication 1997). These physical characteristics, while perhaps a hindrance to the manufacture of formal bifacial tools, would in fact be an advantage in the case of unmodified flake tools in which edge-strength and durability are typical draw backs (Brose 1975; Howes 1980; Walker 1978).

Given these conditions it seems likely that for Early Prehistoric Groups in the Eastern Slopes unmodified/expedient flake technology comprised a greater portion of their technology than it did among many other groups in the continent at that time. Obviously there are likely other areas in the continent that exhibit the same or similar conditions.

The occurrence of exotic and potentially exotic raw materials in many Eastern Slopes sites in the Late Middle and Late Prehistoric periods (e.g., Darwent 1995; Francis 1997) would tend to indicate changes in technologies in these later periods that may be a reflection of increased population densities or changes in intergroup relations. These are issues that require specific research.

If it is the case that unmodified/expedient flake technology was an important component of Early Prehistoric (and likely Early Middle Prehistoric) adaptations then this warrants greater effort expended, during site assemblage analysis, attempting to determine as accurately as possible frequencies of utilized flakes. Analysis of Eastern Slopes assemblages has generally mirrored that *typical* of other regions in which unaided examination and detection of macroscopic edge-damage was the extent of the concern with unmodified flake tools (Young and Bamforth 1990). Obviously exceptions to this statement exist, with Bamforth (1985) and Le Blanc (1984) as examples put forth here.

Much of this easily recognized edge-damage or retouch is likely typically associated with scraping applications by the analysts who observe it in assemblages. This may be reasonable in many cases. Most edge-damage of this degree, unless it can be identified as retouch, would likely be classified as Easily Discernible Wear as it is defined here. This level of edge-damage was produced in the experiments here exclusively through application of the tool to hard materials (dry wood and dry antler) and almost exclusively in scraping tasks. If only tasks involving hard materials produce Easily Discernible Wear then analytical approaches that only detect flakes with this level of use-wear have only demonstrated that these specific tasks may have been carried out at the site. This approach will have failed to detect any evidence of other types of tasks at that site. In fact, these approaches would be failing to look for evidence of those behaviours (e.g., butchering, meal preparation, hide processing) that may be the most diagnostic of site use or general site type. Carving or whittling, which would be associated with such things as tool production/maintenance, may be tasks that would be carried out by individuals at sites of all types (e.g., base camps, short term/transit camps, game reconnaissance locations, special purpose foray sites for specific resource exploitation, and perhaps kill sites).

It has been suggested that, in fact, the macroscopic edge-damage often identified as retouch of a utilized edge is actually backing, as commonly referred to in Old World archaeology, which is done to protect the user's hand in which case any use-wear would be on an opposite or adjacent edge (Frison and Bradley 1980: 85).

The idea that utilized flakes are likely largely going unrecognized in assemblages is not a novel suggestion. Brose discovered this in the course of use-wear experiments carried out in the early 1970s (Brose 1975: 87). Young and Bamforth (1990) demonstrated the tendency, among a sample group of professional archaeologists, for major inconsistencies and outright errors in the unaided examination and identification of macroscopic edge-damage.

The experiments carried out here support this suggestion. Of the nine flakes used in Part A to dress out a deer only two (22%) acquired a degree of wear that might be detectable without the aid of magnification and even this is tenuous. Of the 54 flakes applied to the variety of tasks in Part B of the experimentation nine (17%) acquired wear to a degree likely detectable without magnification. Of these nine flakes all had been applied to hard materials and seven had been used in a scraping manner. Based on these results approximately 80% of the flakes used would have gone undetected if they had been in an archaeological assemblage. This would not have translated into

80% of an assemblage, however, as the unavoidable waste debitage (those flakes too small or lacking suitable morphology for use) were not included here.

In the analysis of the archaeological samples similar results were observed. On average between the three sites approximately 2% of the Early Prehistoric and 2% of the Middle Prehistoric assemblages were identified as utilized in the unaided examination carried out during initial analysis of the assemblages for the site reports. This was increased to approximately 7% and 4% of the *whole assemblages* respectively with the microscopic examination of just *small samples* of each assemblage. The percentage of the samples that were identified as having edge-damage consistent with that observed on the experimentally utilized flakes was actually 67% for the Early Prehistoric and 62% for the Middle Prehistoric assemblages.

Both the archaeological evidence (Bamforth 1985) and ethnographic evidence (Miller 1979 and White 1968) strongly suggest that size is an important criterion in the selection of flakes for use as unmodified tools. The cutoff point below which a flake is simply too small for use as a hand-held tool is around 5 or 10 mm in maximum dimension. When all debitage in the assemblages < 5 mm are excluded the probability that a flake will have edge-damage is between approximately 65 and 75% for flakes < 50 mm and 80+% for flakes >50 mm for the Early Prehistoric assemblages and between approximately 60 and 70% for flakes < 50 mm and 75+% for flakes >50 mm for the Middle Prehistoric assemblages.

It is suggested here that even with low-powered examination identifying some of the visible damage as actual use-wear is still tenuous. Flakes having more than what was designated here as minor wear would, however, be relatively confidently identified as utilized. With degree of edge-damage taken into account the probability that a flake will have >minor edge-damage is between approximately 50 and 65% for flakes < 50 mm and 80+% for flakes >50 mm for the Early Prehistoric assemblages and between approximately 35 and 50% for flakes < 50 mm and 50+% for flakes >50 mm for the Middle Prehistoric assemblages.

The results of both the experiments indicate that up to 80% of utilized flakes may be undetectable without aid of magnification. The analysis of the archaeological assemblages indicates that 50% or more of the debitage that is >5 mm in maximum dimension in these assemblages, and by inference other Eastern Slopes assemblages, may be comprised of utilized flakes.

The resulting suggested methodology for application to assemblages to detect utilized flakes is quite simple and includes only a few points.

1/ Examination, with respect to edge-damage, need only be applied to flakes greater than 5 mm in maximum dimension and, in fact, if it were applied only to flakes >10 mm the number of missed utilized flakes would be expected to be negligible. If the assemblage being addressed is of a size that would practically preclude the examination of all debitage > 5 or 10 mm then suitable samples can be taken and the results of this analysis extrapolated from.

2/ Prior to examination with magnification, close examination of each flake (of appropriate size) should be done without magnification. This can provide a better determination of those edges that would be most suitable for applications and are likely to warrant the most microscopic attention. Results here indicated that those flakes initially categorized as having No Discernible Wear tended not to exhibit any patterned damage under magnification that could be even tentatively considered use-wear. Therefore, it might be considered reasonable to cut analysis time by including only those flakes with No Obvious Wear or greater in the microscopic examination.

3/ Examination requires only the use of low-powered magnification (20 to 40X) and really any available low-powered microscope would be suitable. The recommendation here is to avoid the use of a hand lense as the limited field of view makes visual orientation difficult and the awkwardness of manual manipulation of flake and lense makes accuracy of observations difficult. This is not to suggest that the use of higher powered magnification is not appropriate, assuming that time constraints and access to equipment are not factors in the analysis. Use of higher power magnification, or a combination of both low and high powered microscopy would undoubtedly be more effective and allow a greater level of confidence in the analysis but, for simple practical reasons tend to be avoided (as per Odell 1982 and e.g., Brisland 1992).

4/ It is recommended that any analyst without much previous experience carry out some limited personal experiments with flake tools of the same or similar raw material as that of the archaeological debitage prior to examination of the assemblage. This will provide a grounding in understanding the conditions necessary to produce varying levels of edge-damage on flakes of that material and the nature of edge-wear produced. These experiments would not need to be extensive or particularly time consuming in order to provide a reasonable control sample.

5/ Interpretation of edge-damage as potential use-wear must revolve around patterning of edge-damage as opposed to simple presence of damage. This suggestion is not unique to this thesis. Many use-wear studies have emphasized that the difference between actual use-wear and incidental damage is a lack of patterning in the latter. (A potential problem with high-power magnification may be some difficulty in recognizing patterning over larger portions of an edge when the field of view covers only a very small portion of the edge at one time). Observations of the experimental flakes employed here indicated that some use-wear occurred as unpatterned edge-damage but that, as was indicated by other researchers, being able to confidently distinguish this wear from incidental wear would be difficult at best. Using this lowpowered approach only those flakes with edge-damage that occurred with some patterning to it (e.g., sections of contiguous microscars) should be considered as potentially utilized.

The methodology outlined above is suggested for application in general site assemblage analysis. It would be suitable for the level of analysis typically carried out for general site/excavation reports. The methodology is obviously not suitable for levels of analysis intended to determine more specific aspects of behaviour such as specific tool-task applications or site activity areas. Much more experimentation and research in use-wear studies in general and in the specifics of use-wear as it occurs on materials other than obsidian and cherts/flints is required for these sorts of investigations. While this thesis has focused on issues of identifying utilized flakes and the implications of the degrees of their presence in assemblages, it is important that work also be carried out, with comparable raw materials, that deals with determining specific *function to edge-damage* relationships.

Lithic analysts studying specific site assemblages in an effort to increase the level and strength of interpretations of past behaviour carried out at that location tend to be content to simply determine if utilized unmodified flake tools are present or not. This is slightly akin to noting the presence of a bifacial reduction flake in an assemblage and leaving the interpretation of reduction processes carried out at that site at that. There is an understanding that the application of certain analytical techniques to assemblages can better determine the type and stage(s) of reduction carried out at a site and that this can aid in the building of an understanding of the technological organization and other facets of prehistoric cultures. Similarly, archaeologists should be inclined to develop and apply analytical techniques that provide a better understanding of other activities (general or specific) that may have been carried out at those same sites. While there are, at present, still problems associated with use-wear studies, these are mainly with respect to the differentiation of specific activities. Certainly, determining evidence of specific activities is still wrought with ambiguities. However, if we are able to identify evidence of more general activities (e.g. scraping tasks, cutting, tasks, carving tasks) this is unquestionably useful data in site interpretation and eventually regional interpretation.

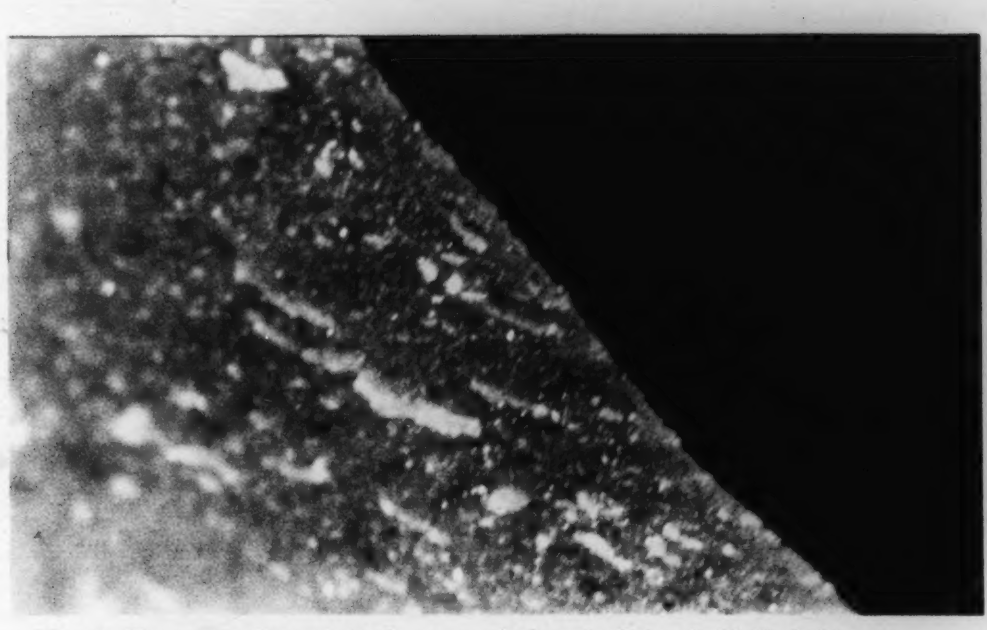


Plate 1 Plan-view photograph of an unused edge of a flake of silicified siltstone magnified 15 times.

Plate 2 Oblique view photograph of an unused edge of a flake of silicified mudstone magnified 15 times.

Plate 3 Photograph of spontaneous retouch which occurred on a flake of silicified siltstone during it's removal from the core - magnified 7.5 times.

Plate 4 Photograph of edge attrition on a flake of silicified siltstone used to scrape antler for 5 minutes. The flake was used with the ventral surface facing the task material. View is of the dorsal surface magnified 7.5 times.

Plate 5 Photograph of ventral side of proximal left margin of flake 5232A from the Early Middle Prehistoric component of site 1626R, magnified15 times. Note 6 contiguous microscars on right half of edge in focus.

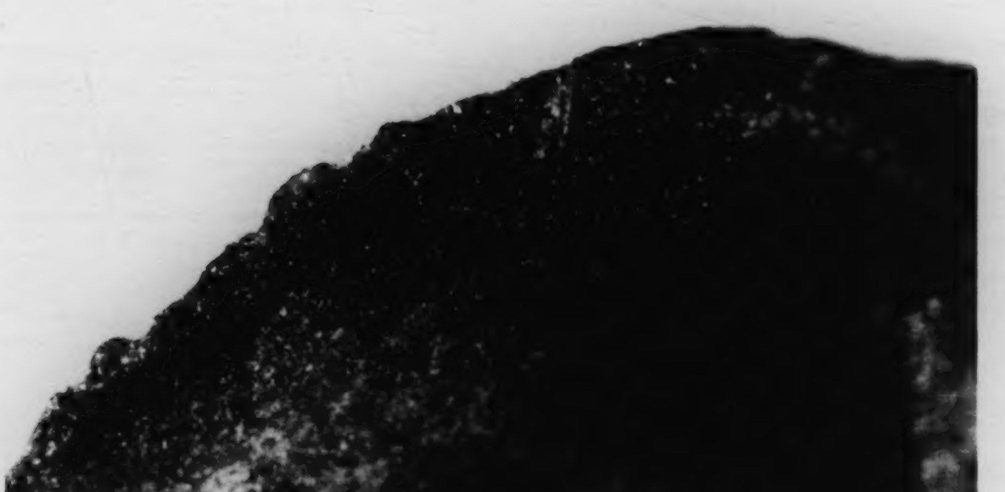


Plate 6 Photograph of dorsal side of distal left margin of flake 5232A from the Early Middle Prehistoric component of site 1626R, magnified15 times. Note 5 contiguous microscars on right half of edge in focus.

References

Ahler, Stanley A.

1979 Functional Analysis of Nonobsidian Chipped Stone Artifacts: Terms, Variables, and Quantification. in Lithic Use-Wear Analysis. edited by Brian Hayden. Academic Press, Inc. pp. 301-328.

Anderson, Ross and B.O.K. Reeves

1975 Jasper National Park Archaeological Inventory. National Historic Parks and Sites Branch Manuscript Report Series 158, Parks Canada, Ottawa.

Andrefsky, William Jr.

1994 Raw-Material Availability and the Organization of Technology. *American Antiquity* 59(1):21-34.

Bacon, C. R.

1983 Eruptive History of Mount Mazama and Crater Lake Caldera, Cascade Range, U.S.A. in ARC Volcanism, edited by S. Aramaki and I. Kushiro. *Journal of Volcanology and Geothermal Research* 18: 57-115.

Bailey, Jeff

1997 X-Ray Fluorescence Analysis of Two Obsidian Artifacts from Ya-Ha-Tinda Ranch, Alberta. Unpublished report prepared for Parks Canada Archaeological Services, Calgary.

Bamforth, Douglas B.

1985 The Technological Organization of Paleo-Indian Small-Group Bison Hunting on the Llano Estacado. *Plains Anthropologist* 30:243-58.

1986 Technological Efficiency and Tool Curation. *American Antiquity* 51(1)38-50.

Bamforth, Douglas B., George R. Burns, and Craig Woodman

1990 Ambiguous Use Traces and Blind Test Results: New Data. *Journal of Archaeological Science* 17: 413-30.

Beaudoin, Alwynne B.

1996 Personal communication.

1993 A Compendium and Evaluation of Postglacial Pollen Records in Alberta. *Canadian Journal of Archaeology* 17: 92-112.

1986 Using *Picea/Pinus* Ratios from the Wilcox Pass Core, Jasper National Park, Alberta, to Investigate Holocene Timberline Fluctuations.*Geographie physique et Quaternaire* XL (2) p. 145-52.

Beaudoin, Alwynne B. and Roger H. King

1990 Late Quaternary Vegetation History of Wilcox Pass, Jasper National Park, Alberta. *Palaeogeography, Palaeoclimatology, Palaeoecology* 80: 129-44.

Bettinger, Robert L.

1991 Hunter-Gatherers: Archaeological and Evolutionary Theory. Plenum Press, New York

Binford, L. R.

1980 Willow Smoke and Dog's Tails: Hunter-Gatherer Settlement Systems and Archaeological Site Formation. *American Antiquity* Vol.45 (1) 4-20.

1979 Organization and Formation Processes: Looking at Curated Technologies. *Journal of Anthropological Research* 35:255-73.

1977 Forty-seven Trips: a Case Study in the Character of Archaeological Formation Processes. In Stone Tools as Cultural Markers: Change, Evolution and Complexity. pp. 24-36. Edited by R.V.S. Wright. Australian Institute of Aboriginal Studies, Canberra.

Brink, J.W.

1997 Personal communication.

1978 An Experimental Study of Microwear Formation on Endscrapers. National Museum of Man, Mercury Series, Archaeological Survey of Canada Paper 83. National Museums of Canada, Ottawa.

Brink, J. W. and Robert J. Dawe

1986 An Introduction to the Archaeology of the Grande Cache Region in the North Alberta Rocky Mountains. In Eastern Slopes Prehistory: Selected Papers. Edited by Brian Ronaghan. Archaeological Survey of Alberta Occasional Paper No. 30. pp. 161-246.

Brisland, Richard T. W.

1992 Camas Processing or Upland Hunting: An Interpretation of Lithic Scatters at High Prairie. Unpublished MA thesis, Department of Archaeology, University of Calgary.

Brose, David S.

1975 Functional Analysis of Stone Tools: a Cautionary Note on the Role of Animal Fats. *American Antiquity* 40(1)86-94.

Bryan, A.

1997 Personal communication.

Cahen, D. and J. Moeyersons

1977 Subsurface Movement of Stone Artifacts and Their Implications for the Prehistory of Central Africa. *Nature* 266: 812-15.

Christensen, O. A.

1971 Banff Prehistory: Prehistoric Subsistence and Settlement in Banff National Park, Alberta. National Historic Sites Service Manuscript Report 67, Ottawa, Ontario.

Crabtree, Don E.

1977 The Obtuse Angle as a Functional Edge. in Experimental Archaeology, edited by Daniel Ingersoll, John E. Yellen, and William MacDonald. pp.38-51.

Darwent, John

1995 Preliminary Artefact Analysis for the Scalp Creek Threatened Sites Project, Ya-Ha-Tinda Ranch 1993-1994. Prepared for Parks Canada Archaeological Services, Calgary.

Dawe, Robert

1997 Personal communication.

Dawe, Robert and Brian Ronaghan

1997 An Unusual Early Archaic Sidenotched Point from James Pass, Alberta. Paper presented at the annual Society for American Archaeology Conference.

Driver, Jonathan C.

1978 Holocene Man and Environments in the Crowsnest Pass, Alberta. Unpublished Ph.D. dissertation, Department of Archaeology, University of Calgary, Calgary, Alberta.

1976 Excavations and Survey of the Crowsnest Pass. In Archaeology in Alberta, 1975. Compiled by J. M. Quigg and W. J. Byrne. Archaeological Survey of Alberta Occasional Paper No. 1. Edmonton.

Duke, P. G.

1986 A Locational and Subsistence Analysis of Pelican Lake Phase Sites in Crowsnest Pass, Alberta. In Eastern Slopes Prehistory: Selected Papers. Edited by Brian Ronaghan. Archaeological Survey of Alberta Occasional Paper No. 30. pp. 3-20.

Elliot, Jack

1970 Jasper National Park and Ya-Ha-Tinda Ranch Archaeological Survey Preliminary Report, 1970. National Historic Sites Service Manuscript Report Series 44, National and Historic Parks Branch, Department of Indian Affairs and Nothern Development, Ottawa.

Feder, Kenneth L.

1981 Waste Not, Want Not - Differential Lithic Utilization and Efficiency of Use. *North American Archaeologist* 2(3)193-205.

Fedje, Daryl W.

1988 The Norquay and Eclipse Sites: Trans-Canada Highway Twinning Mitigation in Banff National Park. Parks Canada Microfiche Report Series No. 286, Ottawa.

1987 Archaeological Survey and Assessment, Upper Red Deer River Valley, Banff National Park. Archaeological Research Services, Canadian Parks Service, Western Region, Calgary. Microfiche Report Series no. 386.

1986 Banff Archaeology 1983-85. In Eastern Slopes Prehistory: Selected Papers. Edited by Brian Ronaghan. Archaeological Survey of Alberta Occasional Paper No. 30. pp. 25-62.

Fedje, Daryl W., James M. White, Michael C. Wilson, D. Erle Nelson, John S. Vogel, and John R. Southen.

1995 Vermillion Lakes Site: Adaptation and Environments in the Canadian Rockies During the Latest Pleistocene and Early Holocene. *American Antiquity* 60(1):81-108.

Flennikan, J. Jeffery and James C. Haggarty

1979 Trampling as an Agency in the Formation of Edge Damage: An Experiment in Lithic Technology. *Northwest Anthropological Research Notes* 13: 208-214.

Francis, P. D.

1997 Scalp Creek Threatened Sites Project. Report on file with Parks Canada Archaeological Services, Calgary.

1996 Personal communication.

Frison, George C.

1991 Prehistoric Hunters of the High Plains. Academic Press, New York.

1989 Experimental Use of Clovis Weaponry and Tools on African Elephants. *American Antiquity* 54(4):766-84.

Frison,George C. and Bruce A. Bradley

1980 Folsom Tools and Technology: at the Hanson Site, Wyoming. University of New Mexico Press, Albuquerque.

Gadd, Ben

1995 Handbook of the Canadian Rockies. Corax Press, Jasper, Alberta.

Gallagher, James P.

1977 Contemporary Stone Tools in Ethiopia: Implications for Archaeology. *Journal of Field Archaeology* 4:407-14.

Gero, Joan M.

1991 Genderlithics: Women's Roles in Stone Tool Production. in Engendering Archaeology: Women and Prehistory, edited by Joan M. Gero and Margaret W, Conkey, pp. 163-93. Basil Blackwell Ltd., Oxford.

Gifford-Gonzalez, Diane P. et al.

1985 The Third Dimension in Site Structure: An Experiment in Trampling and Vertical Dispersal. *American Antiquity* 50(4)803-18.

Goodman, Mary Ellen

1944 The Physical Properties of Stone Tool Materials. *American Antiquity* 9: 415-33

Gould, R. A.

1980 Living Archaeology. Cambridge University Press, New York.

Gould, R. A. and S. Saggers

1985 Lithic Procurement in Central Australia: A Closer Look at Binford's Idea of Embeddedness in Archaeology. *American Antiquity* 50(1):117-136.

Gramley, Richard M.

1980 Raw Material Source Areas and "Curated" Stone Tool Assemblages. *American Antiquity* 45(4):823-833.

Grace, R., I. D. G. Graham and M. H. Newcomer

1985 The Quantification of Microwear Polishes. *World Archaeology* 17(1)112-20.

Greiser, Sally T. and Payson D. Sheets

1979 Raw Material as a Functional Variable in Use-Wear Studies. in Lithic Use-Wear Analysis. edited by Brian Hayden. Academic Press, Inc.

Gryba, Eugene

1997 Personal communication.

n.d. Unpublished experiments on the effects of heat treating on silicified sedimentary materials from the Alberta Rockies.

1983 Sibbald Creek: 11,000 Years of Human Use of the Alberta Foothills. Occasional Paper 22. Archaeological Survey of Alberta, Edmonton.

Hayden, Brian and Johan Kamminga

1979 An Introduction to Use-Wear: The First CLUW. in Lithic Use-Wear Analysis, edited by Brian Hayden. pp. 1-13. Academic Press, Inc.

Henry, Donald O.

1989 Correlations Between Reduction Strategies and Settlement Patterns In Alternative Approaches to Lithic Analysis. edited by D. O. Henry and G. H. Odell. 85-118. Archaeological Papers of the Anthropological Association No.1.pp. 139-55.

Howes, Donald

1980 Obsidian Butcher Knives: the Formation of Edge Damage on Modified Blades. *Northwest Anthropological Research Notes* 14(2):135-44.

Hudecek-Cuffe, Caroline

1998 Final Report , Department of Anthropology, University of Alberta Archaeological Field School, Jasper National Park (1997 excavations). Prepared for Parks Canada, Canadian Heritage, Western Region, Calgary.

1997 Final Report , Department of Anthropology, University of Alberta Archaeological Field School, Jasper National Park (1996 excavations). Prepared for Parks Canada, Canadian Heritage, Western Region, Calgary.

Ives, J. W.

1990 A Theory of Northern Athapaskan Prehistory. University of Calgary Press, Calgary. Westview Press, Boulder, Colorado.

Jones, Peter R.

1980 Experimental Butchery with Modern Stone Tools and its Relevance to Paleolithic Archaeology. *World Archaeology* 12(2):153-65.

Keeley, Lawrence H.

1980 Experimental Determination of Stone Tools Uses. University of Chicago Press.

1977 The Functions of Paleolithic Flint Tools. *Scientific American* 237(5) 108-26

1974 Technique and Methodology in Microwear Studies: a Critical Review.*World Archaeology* 5:323-36.

Keeley, L. and M. Newcomer

1977 Microwear Analysis of Experimental Flint Tools: A Test Case. *Journal of Archaeological Science* 4: 29-62.

Keller, Charles M.

1966 The Development of Edge Damage Patterns on Stone Tools. *Man* 1(4)501-11

Kelly, Robert L.

1988 Three Sides of a Biface. *American Antiquity* 53:717-34.

1983 Hunter-Gatherer Mobility Strategies. *Journal of Anthropological Research* 39: 277-306.

Kelly, Robert L. and Lawrence C. Todd

1988 Coming into the Country: Early Paleoindian Hunting and Mobility. *American Antiquity* 53(2):231-44.

Kennedy, M.

1982 Conservation Excavations at DjPq-1: an 8000 Year Record of Human Occupation in the Crowsnest Pass, British Columbia. (Lifeways of Canada Ltd) Report for Alberta Natural Gas Ltd. Copy on File, Heritage Conservation Branch, Victoria.

Kooyman, Brian

1985 Moa and Moa Hunting: Archaeological Analysis of Big Game Hunting in New Zealand. Unpublished PhD Dissertation, University of Otago, New Zealand.

Kuhn, Steven L.

1994 A Formal Approach to the Design and Assembly of Mobile Toolkits. *American Antiquity* 59(3):426-442.

Lawn, B. R. and D. B. Marshall

1979 Mechanisms of Microcontact Fracture in Brittle Solids. in Lithic Use-Wear Analysis. edited by Brian Hayden. Academic Press, Inc.

Le Blanc, Raymond Joseph

1984 The Rat Indian Creek Site and the Late Prehistoric Period in the Interior Northern Yukon. National Museum of Man, Mercury Series, Archaeological Survey of Canada Paper 120.

Loveseth, Beatrice A.

1976 Lithic Source Survey in the Crowsnest Pass Area. In Archaeology in Alberta, 1975, compiled by J. M. Quigg and W. J. Byrne, pp.51-58. Archaeological Survey of Alberta Occasional Paper No. 1, Edmonton.

Luckman, B.H. and M.S. Kearney

1986 Reconstruction of Holocene Changes in Alpine Vegetation and Climate in the Maligne Range, Jasper National Park, Alberta. *Quaternary Research* 26: 244-61.

Luedtke, Barbara E.

1992 An Archaeologist's Guide to Chert and Flint. Archaeological Research Tools 7, Institute of Archaeology, University of California, Los Angeles.

MacDonald, George F. and David Sanger

1968 Some Aspects of Microscope Analysis and Photomicrography of Lithic Artifacts. *American Antiquity* 33(2) 237-40.

Magne, Martin

1997 Personal communication.

Magne, M. P. R. and J. W. Ives

1991 The First Albertans Project: 1988 Research. In Archaeology in Alberta, 1988 and 1989. edited by Martin P. R. Magne, pp. 101-12. Occasional Paper 33. Archaeological Survey, Provincial Museum of Alberta, Alberta Culture and Multiculturalism, Edmonton, Alberta.

McBrearty, Sally, Laura Bishop, Thomas Plummer, Robert Dewar, and Nicholas Conard

1998 Tools Underfoot: Human Trampling as an Agent of Lithic Artifact Edge Modification. *American Antiquity* 63(1): 108-29.

Meltzer, David J.

1985 On Stone Procurement and Settlement Mobility in Eastern Fluted Point Groups. *North American Archaeologist* vol.6(1).

Miller, Tom O. Jr.

1979 Stonework of the Xeta Indians of Brazil. In Lithic Use-Wear Analysis. Edited by Brian Hayden. Academic Press, New York. pp. 401-7.

Morgantini, Luigi E.

1995 The Ya-Ha-Tinda: An Ecological Overview. Prepared for Parks Canada, Albert Region.

Morlan, Richard E.

1973 A Technological Approach to Lithic Artifacts from Yukon Territory. National Museum of Man, Mercury Series, Archaeological Survey of Canada, Paper No. 7, Ottawa.

Nance, J. D.

1971 Functional Interpretations from Microscopic Analysis. *American Antiquity* 36(3):361-66.

Newcomer, M. H.

1976 Spontaneous Retouch. In "Second International Imposium on Flint, Maastricht" Edited by G. H. G. Engelsen. *Staringia* 3:62-64.

Newcomer, M., R. Grace, and R. Unger-Hamilton

1986 Investigating Microwear Polishes with Blind Tests. *Journal of Archaeological Science* 13:203-17.

Newton, B.

1991 Bow Corridor Project: Summary of the 1988-89 Research. In Archaeology in Alberta, 1988 and 1989. edited by Martin P. R. Magne pp. 113-26. Occasional Paper 33. Archaeological Survey, Provincial Museum of Alberta, Alberta Culture and Multiculturalism, Edmonton, Alberta.

Nielsen, Axel E.

1991 Trampling the Archaeological Record: an Experimental Study. *American Antiquity* 56(3): 483-503.

Odell, George H.

1982 Emerging Directions in the Analysis of Prehistoric Stone Tool Use. *Reviews in Anthropology* 9(1): 17-33.

1980 Butchering with Stone Tools: Some Experimental Results. *Lithic Technology* IX(2): 39-47.

Odell, George H. and Frieda Odell-Vereecken

1980 Verifying the Reliability of Lithic Use-Wear Assessments by 'Blind Tests': the Low Power Approach. *Journal of Field Archaeology* 7(1): 87-120.

Parry, William J. and Robert L. Kelly

1987 Expedient Core Technology and Sedentism. in The Organization of Core Technology, edited by Jay K. Johnson and Carol A. Morrow. pp. 285-304.

Pettijohn, F. J.

1975 Sedimentary Rocks. Harper and Row, New York.

Pheasant, David Richard

1968 The Glacial Geomorphology of the Ya-Ha-Tinda Area, Alberta. Unpublished MA thesis, Department of Geography, University of Calgary.

Pickard, Rodney John

1984 Historical Resources Inventory, Jasper National Park 1983. Staff Report on file, Parks Canada, Calgary.

Pielou, E. C.

1991 After the Ice Age: the Return of Life to Glaciated North America. The University of Chicago Press, Chicago.

Pryor, J.

1988 The Effects of Human Trample Damage on Lithics: A Model of Crucial Variables. *Lithic Technology* 17: 45-50.

Reeves, B. O. K.

1976 1975 Archaeological Investigations at the Lake Minnewanka Site (EhPu-1). Manuscript on file, Archaeological Services, Parks Canada, Calgary.

1975 Prehistoric Archaeological Research on the Eastern Slopes of the Canadian Rocky Mountains (1967-71). *Canadian Archaeological Association Bulletin* 6:1-31.

1974 Crowsnest Pass Archaeological Project 1972 Salvage, Excavation and Survey Paper No. 1, Preliminary Report. National Museum of Man Mercury Series, Archaeological Survey of Canada Paper 19, Ottawa..

1973 An Inventory of Archaeological Sites in the Rocky Mountain, Edson and Grande Prairie Forest Reserves and Adjacent Areas of the Crowsnest Pass and Bow Corridor. Research Report on File, Archaeological Survey of Alberta, Edmonton.

1972a The Prehistory of Pass Creek Valley, Waterton Lakes National Park. National Historic Sites Service Manuscript Report Series 69, Ottawa.

1972b Archaeological Evaluation, Highway no. 940 from Trans Canada Highway to Kanaskis Lakes. Department of Archaeology, University of Calgary, Calgary.

1971 Archaeological Investigations in Waterton Lakes National Park: Preliminary Report 1971. Appendix IIA in Archaeological Resource Inventory of Waterton Lakes National Park. Contract Report (University of Calgary) for Parks Canada. Copy on file, Parks Canada, Waterton Lakes National Park, Alberta.

1970 Archaeological Investigations in Waterton Lakes National Park: Preliminary Report 1970. Appendix IA in Archaeological Resource Inventory of Waterton Lakes National Park. Contract Report (University of Calgary) for Parks Canada. Copy on file, Parks Canada, Waterton Lakes National Park, Alberta.

1967 Archaeological Investigations in Waterton Lakes National Park: Preliminary Report 1967. Contract Report (University of Calgary) for Parks Canada. Copy on file, Parks Canada, Waterton Lakes National Park, Alberta.

1968 Archaeological Investigations in Waterton Lakes National Park: Preliminary Report 1968. Contract Report (University of Calgary) for Parks Canada. Copy on file, Parks Canada, Waterton Lakes National Park, Alberta.

1969 Archaeological Investigations in Waterton Lakes National Park: Preliminary Report 1969. Contract Report (University of Calgary) for Parks Canada. Copy on file, Parks Canada, Waterton Lakes National Park, Alberta.

Reeves, B. O. K. and Jonathan C. Driver

1978 Archaeological Investigations - Crowsnest Pass; Site DjPo-47, 1977 Field Season (ASA Permit 77-68). Research Report for the Canada Council. Copy on file, Archaeological Survey of Alberta, Edmonton.

Ricklis, Robert A. and Kim A. Cox

1993 Examining Lithic Technological Organization as a Dynamic Cultural Subsystem: the Advantages of an Explicitly Spatial Approach. *American Antiquity* 58(3):444-61.

Ronaghan, Brian

1993 The James Pass Project: Early Holocene Occupation in the Front Ranges of the Rocky Mountains. *Canadian Journal of Archaeology* 17: 85-91.

1986 The Status of Prehistoric Research in Alberta's Eastern Slopes. In Eastern Slopes Prehistory: Selected Papers. Archaeological Survey of Alberta Occasional Paper No. 30.pp. 269-353.

1980 Functional Variation in Pelican Lake Assemblages: Crowsnest Pass, Alberta. MA Thesis, Department of Archaeology, University of Calgary, Calgary.

Ronaghan, Brian and A. B. Beaudoin

1988 An Archaeological Survey in the Upper North Saskatchewan River Valley. In Archaeology in Alberta, 1987. Archaeological Survey of Alberta Occasional Paper 32, Alberta Culture and Multiculturalism. Edmonton, Alberta.

Ronaghan, Brian, Alison Landels and Gwyn Langeman

1982 Conservation Excavations at DjPq-2: A Stratified Campsite in the Crowsnest Pass. (Lifeways of Canada Ltd.) Report for Alberta Natural Gas Ltd., Copy on File, Heritage Conservation Branch, Victoria.

Rutter, N. W.

1984 Pleistocene History of the Western Canadian Ice-free Corridor. In Quaternary Stratigraphy of Canada - A Canadian Contribution to I.G.C.P. Project 24, edited by R.J. Fulton, pp.49-56. Geologic Survey of Canada Paper 84-10.

Sandgathe, D. M.

1997 Analysis of the 1993, 1994 and 1996 Artifacts, Scalp Creek Threatened Sites Project, Ya-Ha-Tinda Ranch, Alberta. Prepared for Archaeological Services, Parks Canada, Western Region, Calgary.

Sanger, David

1970 Mid-Latitude Core and Blade Traditions. *Arctic Anthropology* VII(2): 106-117.

Schiffer, Michael B.

1979 The Place of Lithic Use-Wear Studies in Behavioral Archaeology. In Lithic Use-Wear Analysis. Edited by Brian Hayden. Academic Press, Inc.

Semenov, S. A.

1964 Prehistoric Technology. M. W. Thompson, translation. Cory, Adams, and Mackay, London.

Shea, John J. and Joel D. Klenck

1993 An Experimental Investigation of the Effects of Trampling on the Results of Lithic Microwear Analysis. *Journal of Archaeological Science* 20: 175-94.

Sheets, Payson D.

1973 Edge Abrasion During Biface Manufacture. *American Antiquity* 39(2): 215-18.

Shott, Michael J.

1989a On Tool-Class Lives and the Formation of Archaeological Assemblages. *American Antiquity* 54(1):9-30.

1989b Diversity, Organization and Behavior in the Material Record: Ethnographic and Archaeological Examples. *Current Anthropology* 30(3):283-315

1986 Technological Organization and Settlement Mobility: An Ethnographic Examination.*Journal of Anthropological Research* 42:15-50.

Strathern, M.

1969 Stone Axes and Flake Tools: Evaluations from Two New Guinea Highland Societies. Proceedings of the Prehistoric Society 35:311-29.

Sullivan, Allan P. and Kenneth C. Rozen

1985 Debitage Analysis and Archaeological Interpretation. *American Antiquity* 50(4): 755-79.

Tankersley, Kenneth B.

1991. A Geoarchaeological Investigation of Distribution and Exchange in the Raw Material Economies of Clovis Groups in Eastern North America. *Publications in Anthropology* 19:285-97.

Thomas, David Hurst

1976 Figuring Anthropology: First Principles of Probability and Statistics. Holt, Rinehart and Winston, New York.

Tringham, Ruth, Glenn Cooper, George Odell, Barbara Voytek, Anne Whitman

1974 Experimentation in the Formation of Edge Damage: A New Approach to Lithic Analysis. *Journal of Field Archaeology* 1:171-96.

Van Dyke, S.

1987 Banff Resource Description Reconnaissance - 1986. Manuscript on File, Archaeological Research Services Unit, Canadian Parks Service, Western Region, Calgary.

Vaughn, Patrick C.

1985 Use-Wear Analysis of Flaked Stone Tools. University of Arizona Press, Tucson.

Vickers, J. Roderick

1986 Alberta Plains Prehistory: A Review. Archaeological Survey of Alberta Occasional Paper No. 27. Alberta Culture, Historical Resources Division.

Vivian, Brian

1997 Personal communication.

Walker, Phillip J.

1978 Butchering and Stone Tool Function. *American Antiquity* 43(4): 710-15.

Warren, H.

1923 Sub-Soil Pressure Flaking. *Proceedings of the Geologists Association* 34:153-75.

Wayman, Michael

1997 Personal communication .

White, J. P.

1969 Typologies for Some Prehistoric Flaked Stone Artefacts of the Australian /New Guinea Highlands. Archaeology and Physical Anthropology in Oceania 4:18-48.

1968 Ston Naip Bilong Tumbuna: The Living Stone Age in New Guinea. In La Prehistoire, Problems, et Tendances. Edited by D. Sonneville-Bordes, pp. 511-516. Paris: CNRS.

White, J. P. and D. H. Thomas

1972 What Mean These Stones? Ethnotaxanomic Models and Archaeological Interpretations in the New Guinea Highlands. In Models in Archaeology. Edited by D. L. Clarke, pp. 275-308. Metheun, London.

Wiant, Michael D. and Harold Hassan

1984 The Role of Lithic Resource Availability and Accessibility in the Organization of Lithic Technology. in *Lithic Resource Procurement: Proceedings from the Second Conference on Prehistoric Chert Exploitation*, edited by Susan C. Vehik, Center for Archaeological Investigations, Occasional Paper 4: 101-14.

Yerkes, Richard W.

1987 Prehistoric Life on the Mississippi Floodplain: Stone Tool Use, Settlement Organization, and Subsistence Practices at the Labras Lake Site, Illinois. University of Chicago Press, Chicago.

Young, Donald and Douglas B Bamforth

1990 On the Macroscopic Identification of Used Flakes. *American Antiquity* 55(2) 403-9

Appendix A

Experimental Use-Wear Record Sheets Sheet #____

Tool Catalog Number____________________ Tool Material________________
Length________________ Width_______________ Weight__________
Edge Angle (s) 1/________________ 2/_______________ 3/_ _
Task Material ____
Duration of Task: minutes_________________
#Strokes___________________

Task Description: (motor patterns and other comments)___________________
____
____
____

Experimental Use-Wear Record Sheets Sheet #___

Tool Catalog Number_________________ _ Tool Material________________
Length________________ Width_______________ Weight__________

Edge Angle (s) 1/________________ 2/_______________3/_______ _
Task Material ____
Duration of Task: minutes______________ _
#Strokes___________________

Task Description: (motor patterns and other comments)_______________
_ ____
____
____